The

RESEARCH QUARTERLY

PUBLISHED BY THE AMERICAN ASSOCIATION FOR HEALTH, PHYSICAL EDUCATION AND RECREATION

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American Association for Health, Physical Education, and Recreation

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The Research Quarterly

of the American Association for Health, Physical Education, and Recreation

Elmer D. Mitchell, Ph.D., Editor

VOLUME 14 — MARCH, 1943 — NUMBER 1

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Published in March, May, October, and December by the American Association for Health, Physical Education, and Recreation, 1201 Sixteenth Street, N.W., Washington, D.C. Subscription, $3.00 per year; single copies, $1.00.

Send subscriptions to: 1201 Sixteenth Street, N.W., Washington, D.C.

Editorial and Advertising Office: 1201 Sixteenth Street, N.W., Washington, D. C. Advertising rates on application.

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A Critical Study of Objective Methods For Measuring Anterior Posterior Posture With a Simplified Technique

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Part I

A CRITICAL EVALUATION OF METHODS USED FOR THE MEASUREMENT OF POSTURE

Definitions of "Good" Posture

A SURVEY of the standards of good posture proposed by various authorities was dealt with in the original study in the form of excerpts cited from the following authors: George T. Stafford[29]*; Leah C. Thomas[35]; Grey's *Anatomy*[11]; Dennet[36]; Goldwait[12]; Charles Lowman[19]; R. Tait McKenzie[21]; Lillian Curtis Drew[10]; Mary McMillan[22]; Ivalclare Sprow Howland[16]; Gertrude Hawley[14]; Clifford Sweet[32]; Arthur Steindler[30]; Royal Storrs Haynes[15]; and the Report of the Subcommittee on Orthopedics and Body Mechanics.[23]

In the literature related to standards of "good" posture there were many definitions describing the correct upright position. Authorities emphasized segmental alignment, pelvic inclination, carriage of the head and neck, the distribution of weight on the feet, the curves of the spine, abdominal protuberance, the position of the chest, and the center of gravity in the trunk. When considered collectively there seemed to be general agreement in the choice of criteria used to describe the conditions for "good" posture.

So far as could be judged from the literature, definitions tended to fall into two categories and have been classified: 1) descriptively, and 2) anatomically.

Descriptively, the essentials of an erect posture may be summarized as follows:

The principal segments of the body should be balanced evenly over the base of support. The feet are slightly separated, the toes point straight forward or slightly outward, the weight of the body is borne mainly over the middle of the foot. There is easy extension

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This study contains excerpts from a doctoral dissertation submitted in the Department of Physical Education, in the Graduate College of the State University of Iowa.

* The superior numbers refer to the references cited in the bibliography at end of article.

of the knees and hips. There should be such position of the pelvis bones as will balance the weight directly over the acetabula, the spine functioning as a poised column with the weight distributed about it. This involves the preservation of a moderate curve in the lumbar region and an easy backward position of the shoulders, to bring the weight upon the spine rather than upon the chest. In this position the shoulder blades are approximately flat, the chest is carried moderately high but not thrust forward and there is normal tonus of the abdominal muscles. The head erect also balances easily without backward tension or forward stretch. The position is alert and capable of movement in any direction. It is not an artificial, arbitrary, or complex combination of postural adjustments, but the most natural and comfortable and perfectly poised position which the body can assume in erect standing.

Anatomically, the definition of normal posture is characteristically described in terms of the relationships of the body and its parts to the line of gravity. Anatomically, the standards for normal posture have been summarized as follows:

As viewed from the side, beginning approximately at the atlanto-occipital articulation or externally behind the ear at the mastoid process the line of gravity passes downward posteriorly to the vertebrae of the neck, intersecting the spine near the seventh cervical vertebra, passes anteriorly to the dorsal vertebrae, touches the spine again at the lumbo-sacral junction, passes behind the lumbar spine, passes in front of the sacro-iliac junction to the center of the hip joint, then passes in front of the knee joint and drops to the base of support at the feet directly in front of the ankle joint.

Balanced in this way, with the shoulders retracted, minimum moments of force are said to be in effect for bending the body segments out of the line of balance.

Methods of Measuring Posture

SUBJECTIVE METHODS

The subjective methods for posture evaluation were reviewed, partly for completeness, but chiefly because these methods in the hands of experts have considerable practical value; and because they suggest materials and standards often useful for research purposes. Undoubtedly the strongest argument for the use of subjective methods in the grading of posture is that, in the hands of skilled examiners, they lend themselves readily to situations where qualitative tests for groups are desired. The chief objections to tests of this type are that, depending as they do upon rating by inspection, they are not generally accurate enough for research purposes, permit no permanent or reliable quantitative records, and leave re-

sults open to differences in interpretation. For purposes requiring careful diagnosis or research, more objective, quantitative, and graphic records are desirable.

The following subjective methods were reviewed and evaluated:

1. The Vertical Line test developed by Bancroft.[1]
2. The Triple Line test advocated by Bancroft.[1]
3. Charles C. Lowman's Method of Examination.[19]
4. The Michigan Public School test.
5. The Iowa Posture test.[34]
6. Crampton's Wall tests.[4]

SEMI-OBJECTIVE METHODS

A few methods approaching semi-objective status are noted in the literature: The measures derived by Rowe, and Crampton were: Rowe's percentage of posture measurement;[25] Crampton's Total Ptosis Test;[4] Crampton's Abdominal Ratio.[4]

OBJECTIVE METHODS OF RECORDING POSTURE

For purposes of scientific interest, permanent records in some form are essential. The X-ray, photograph, silhouettograph, schematograph, pantograph, lithograph, and the center of weight apparatus have all been used to obtain graphic and objective records for the scientific study of posture. The X-ray provides an expensive but thoroughly scientific approach to the problem. Photography has been used satisfactorily where expense is not a major consideration. However, it has the disadvantage of positive identification of the subject. The lithograph, pantograph, and schematograph serve best to arouse pupil interest in improvement rather than for purposes of accurate measurement. The center of weight apparatus, described by Lovett and Reynolds* furnishes a means of determining the position of the center of gravity of the body in relation to the base of support and in relation to body segments and landmarks. It may be used alone or in combination with photographs or silhouettes. The silhouettograph technique is less expensive than the use of X-ray or photography, more accurate than the schematograph, and probably represents the most popular addition to graphic methods.

Although authorities differ somewhat as to which methods are most valuable, the matter is considered here under two classifications: a) studies without adequate standards; and b) studies for which adequate validated standards have been developed.

OBJECTIVE METHODS WITHOUT ADEQUATE STANDARDS

The L. C. Drew method of examination[10] employs silhouetto-

* E. S. Reynolds, and R. W. Lovett, "Method of Determining the Position of the Center of Gravity in its Relation to Certain Body Landmarks in the Erect Position." *American Journal of Physiology.* 73 (May, 1909) 286-293.

graphs and schematographs to record and grade posture. The method is relatively inexpensive, easy to administer, and permits a permanent record. The chief objection lies in the subjectivity of judgments, lack of published norms, and the subsequent assignment of posture grades upon an arbitrarily developed basis.

Brownell[2] has validated a usable scale and developed criteria based upon a large number of silhouette pictures taken of ninth-grade boys. This study represents an attempt to develop a continuous scale of postural types. It is generally agreed that posture profiles tend to have some useful relation to types. Though this method produces records which are directly comparable from picture or person to chart, the difficulty of accurate comparison must be considered, since the judgments are again largely subjective.

Mary E. Sweeny and associates[31] of the Merrill Palmer School undertook a preliminary study to develop a photographic technique for the recording of pre-school posture. The measurements which appeared to be most significant were described. No method was developed to insure that the same parts were measured on the photographs as on the body itself, and not enough data were available to establish criteria for judging posture on measurements taken from the photographs. However, the measurements seem to indicate something of the type of data needed to set up posture standards for pre-school children.

The Kellogg[18] measurements are made upon silhouette pictures. This method seems promising, and the claims are interesting. No complete standards were developed based upon statistical or anatomical evidence. Kellogg presents little evidence as to the validity or reliability of his measurements. The method was selected as one to be investigated in the present study.

The Goldthwait Method, as reported by Stafford,[28] consists of the measurement of an angle of deviation formed by the intersection of two lines drawn through four points made on silhouettes. This angulation does not indicate certain postural faults in some individuals where the lines as drawn do not intersect in all postures.

Anderson and Morrill* have devised an instrument called the posturemeter which is essentially a protractor with a movable hand or pointer. The instrument measures the "postural angle" (cervicothoracic angulation) over a graduated range of 90 degrees. The validity of the method is claimed on the basis that each age group studied (measured before and after being taught to assume a correct standing position) raised its average posture from fair to good. No evidence is cited as to the statistical significance of the obtained differences. The reliability of the method is claimed but is not

* Olga Anderson and Warren P. Morrill: "The Measurement of Postures," *Research Quarterly*, 12 (October, 1941) 518-527.

statistically stated. The method is partcularly applicable to large groups.

OBJECTIVE METHODS WITH ADEQUATE OBJECTIVE STANDARDS

Measurements Developed at Springfield

The Static Center of Gravity Test.—This test as adapted and described by Cureton and Wickens[6] indicates the inclination of the center of weight of the body in relation to its base of support. This test is reported to correlate moderately high with kyphosis measurements, with strength, and with power as measured in the Sargent Jump.*

One criticism of this method lies in the probability that poor alignment of body segments might exist without noticeable displacement of the center of weight as measured at the feet. This is true since moments of force set up by some segments being out of vertical alignment might be equalized by compensation in other segments, thus tending to leave the center of weight at the feet relatively undisturbed.

This method, however, is very objective and should prove of value as a device for research in this field.

Measurements Developed from Conformateur-Silhouette Techniques.—Cureton has recently published the Springfield norms for the objective analysis of posture including the following thirteen posture items: poke neck, shoulder thrust, Goldthwait's index, Kellogg's chest ratio, kyphosis, lordosis, abdominal ptosis, hip thrust, knee thrust, big toe angle, arch angle, scaphoid deviation, and center of gravity. He believes that: "no good system exists for evaluating the items scientifically . . . that most of the difficulty in validating posture items has come from lumping the items into an uninterpretable score and correlating this with other things."

The MacEwan and Howe Method.[20]—MacEwan and Howe have developed an objective method of grading posture with photographic technique. So far as may be judged from the literature this study represents the most extensive work undertaken in the objective grading of posture. The contribution is noteworthy in that it presents certain standards of posture, with particular reference to women, based upon a criterion which can be interpreted in terms of actual measurement rather than in descriptive terms subject to differences of opinion. Other methods have consisted largely in looking at an individual, his picture, or silhouette and the subsequent assignment of grades arbitrarily on an A, B, C, D basis or at best with measurements comparable to incomplete stand-

* Thomas K. Cureton, "Bodily Posture as an Indication of Fitness," *Supplement to the Research Quarterly*, 12 (1941) 348-367.

ards. That the authors do not regard this study as conclusive is evidenced by the following quotation:

> . . . It is our intention to analyze the opinions of judges and groups of judges and to secure a stronger criterion of posture. The next step is to rework the whole problem of grading from objective measurements and revise the grading scale accordingly.

SUMMARY

In summary, a consideration of the literature dealing with methods of grading posture reveals that the problem has been approached from many different angles. The philosophy behind the development of posture measurement seems clear and interesting. The emphasis has lately changed from the search for posture types and key dimensions to a more analytical study of body segments and their habitual positions anatomically in order to determine specific relationships or segmental alignment to general poise and posture. In general the chief emphasis seems at present to be placed upon:

1) General body poise, lean, or tilt.
2) The amount of spinal curvature.
3) Segmental angulation relative to a vertical line, longitudinal axis, and the habitual positions of movable joints.

A review of techniques, beginning with the imaginary straight line and ranging from the use of rulers to X-rays, has served mainly to increase objectivity, reliability, and accuracy of measurement. Validity in posture measurement still remains a matter of subjective judgment. There is a rather universal belief in the "goodness" of the erect position. Validity, whenever it has been investigated, has been claimed chiefly upon the basis of agreement among judgments of experts.

PART II
THE STUDY

Nature of the Data.—Two hundred male students between the ages of seventeen and twenty-five furnished the data for this investigation. The subjects were selected from required classes in physical education. Paralytics and cases of noticeable deformity were not included. Fifty anthropometric measurements and a silhouette picture of each subject, standing against a conformateur, were completed during one appointment. A criterion was developed through the combined ratings of experts and was further refined through the use of the method of paired comparisons administered by the writer. Forty selected angles and indices were scaled and measured with protractor and proportional dividers upon the silhouettes. The measurements were recorded in millimeter's or in degrees and correlated with the criterion. Eliminations were made on the basis of low correlations with the criterion and in favor of

convenience and precision of measurement. The remaining variables were then combined statistically and the posture formula expressed in regression form.

Silhouette-Conformateur Technique.—The silhouettograph and conformateur are recognized as satisfactory devices for the scientific study of anterior-posterior posture. A combination silhouette-conformateur technique has been recommended by Cureton. A slight modification of the Cureton-Gunby apparatus was made and used in conjunction with new silhouettograph methods described by Hubbard.[17] Procedure in photostatic setup and in measurement technique adheres in principle to methods adequately described by Cureton and Hubbard.

The lighting equipment consisted of four two-hundred-watt light bulbs which were suspended at intervals of one foot in vertical alignment behind a white cloth screen. A photo-flood light was placed in front of the screen to be turned on during exposure. The conformateur was placed directly in front of the screen. The silhouette camera was placed ten feet in front of the screen. Ordinary 5 x 7 Bromide sensitized paper (Az of No. 3) was used in the camera. The double lighting effect on both sides of the subject and screen gave photographic results on inexpensive paper. Landmarks were easily spotted; musculature and skeletal landmarks were easily seen.

Techniques of Measurement and Photography.—The subject was brought to the laboratory where a number of anthropometric measurements and silhouette pictures were completed during one appointment. (While the anthropometric measurements were not used extensively in this study, the measurements are mentioned here to make clear the whole picture of the laboratory procedure.) The pictures were taken after the measurements had been made, so that the subjects were accustomed to the laboratory environment. Landmarks were designated upon the subject's body with pointed pieces of white adhesive tape placed upon the skin. Such landmarks as were invisible to the camera were designated by small angle irons taped to the skin or by the adjustable rods and pointers on the apparatus. The following landmarks were designated with pointed pieces of tape: the tragion of the ear, the tip of the acromion process, the tip of the great trochanter, and the external malleolus of the ankle. A small angle iron was taped to the suprasternale at the upper margin of the sternum. (See illustration for photographic setup of method of placing subject on conformateur and landmarks.)

The subject was asked to assume a comfortable standing position on the base of the conformateur. An upright standard with two sliding arms were placed in front of the subject. The tips of the sliding arms on the conformateur were adjusted to the spinal curves.

Rods corresponding to the spines of the seventh cervical and fourth lumbar vertebra were pulled out to designate those landmarks. All landmarks were re-checked. The screen was illuminated and the exposure was made. The negatives were unloaded in a photographic dark room and developed.

Establishing the Criterion.—One hundred pictures were selected and rated by three competent judges*, C. H. McCloy, Miss Loraine Frost, and Miss Ruth Bass. Posture was rated by the judges on a possible twelve-point scale ranging from A+ to D—. Thus

Grade	A+	A	A—	B+	B	B—	C+	C	C—	D+	D	D—
Points	12	11	10	9	8	7	6	5	4	3	2	1

The raters were asked to study each silhouette and to assign a grade to each of the following regions: head and neck, upper back, lower back, trunk, and legs. Considering the ratings and studying the whole picture, general poise was then rated on the same scale, ranging from A+ to D—; thus three grades were assigned to general poise for each picture, one by each rater.

It is shown, both from the statements of the judges and the intercorrelations between ratings that posture was judged much upon the same subjective basis. The consistency with which the raters agreed in their judgments was established by intercorrelating the rating of the three judges. The lowest coefficient obtained was found to be .725. The numerical equivalents of the three grades assigned to general poise were added and this sum considered as one hypothetical judgment. The pictures were ranked in order and arranged into a seven-category distribution. Each category was studied and what was considered to be the most representative picture was picked for each of the seven categories to be used as a standard.

Using the seven pictures as standards for comparison, the entire two hundred silhouettes were compared individually with each standard on the scale. The pictures were placed into groups either as better, equal to, or not as good as the postures represented on the scale. This procedure was as follows:

Posture Scale	A		B		C		D		E		F		G	
Possible Groups	1	2	3	4	5	6	7	8	9	10	11	12	13	14

For example, as the pictures were compared with the scale, some might appear to be better than A, others equal to A and better than B, others not as good as A but better than B, etc., until all of the silhouettes had been compared with the standards.

An average was then taken of twenty-five complete ratings, and the postures re-arranged into a nine-category, approximately normal

* C. H. McCloy, State University of Iowa, Iowa City, Iowa; Loraine H. Frost, State University of Iowa, Iowa City, Iowa; Ruth I. Bass, University of Texas, Austin, Texas.

distribution. This was taken as the final criterion with which to correlate objective data. The latter was obtained by taking measurements upon the silhouettes, to be correlated with the criterion.

In preparing the pictures, the following precision instruments used were:

a) A celluloid protractor, an instrument for laying down angles.

b) A proportional divider consisting of two legs on a sliding adjustable pivot, making it possible, when the legs were open to have definite proportion to the distance between the points at the opposite end.

c) A supply of very hard lead pencils.

d) A hand magnifying glass.

A flexible desk lamp, bulb removed, was fitted with a magnifying glass in order to leave both hands free for measurement. Perforations were made upon the pictures at points designated by the landmark, i. e., the tragion of the ear, tip of acromion process, the top margin of the sternum, the lower tip of the sternum, the symphysis pubis, the upper tip of the great trochanter, the center of the knee joint, the external malleolus of the ankle, the tips of the seventh cervical spine and the fourth lumbar spine. Perforations were also made at the mid-points of the cervical, the dorsal, and lumbar spine, and at points on the spine at the level of the top of the sternum and the lower tip of the sternum. Points were placed on the abdomen at the level of the fourth lumbar spine and at the greatest point of abdominal protuberance. Horizontal lines, connecting the fourth lumbar vertebra with the abdomen, and the tip of the sternum with the spine, were laid down, bisected, and perforations made at their mid-points. The line of pelvic inclination (the line connecting the symphisis pubis to the fourth lumbar spine) was also bisected. Fine lines were then laid down connecting the perforated points with a ruler and hard lead pencil. Precision of measurement was stressed throughout. Degrees were read upon the protractor and linear dimensions upon a millimeter ruler with the aid of the magnifying glass. Where there was any doubt lines and angles were enlarged and reproduced with the proportional dividers relative to known ratios of the original.

Figure I shows a drawing of all angles measured on the silhouettes for purposes of experimentation. Figure II shows the four angles finally selected for the measurement of segmental angulation as we developed in this study.

The following measurements were scaled upon the pictures and recorded in fractional degrees and/or millimeters. (Figure I.)

Angle I.—Lines connecting the tragion to a midpoint bisecting a horizontal line drawn from the suprasternale to the spine; and to a mid-point bisecting the horizontal lumbale-anterior abdomen line.

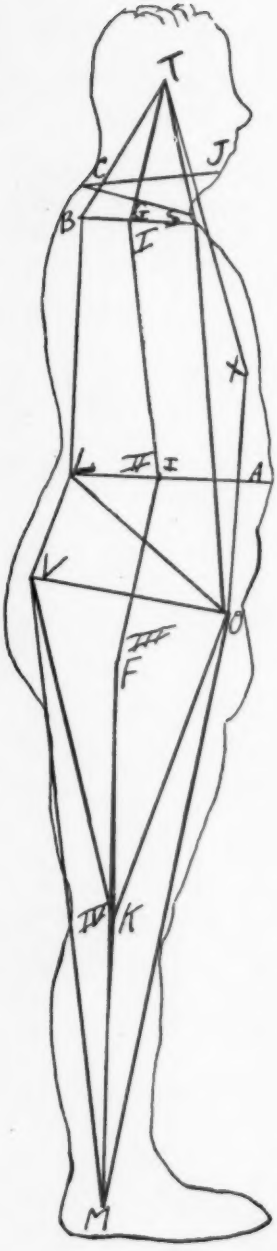

Figure I

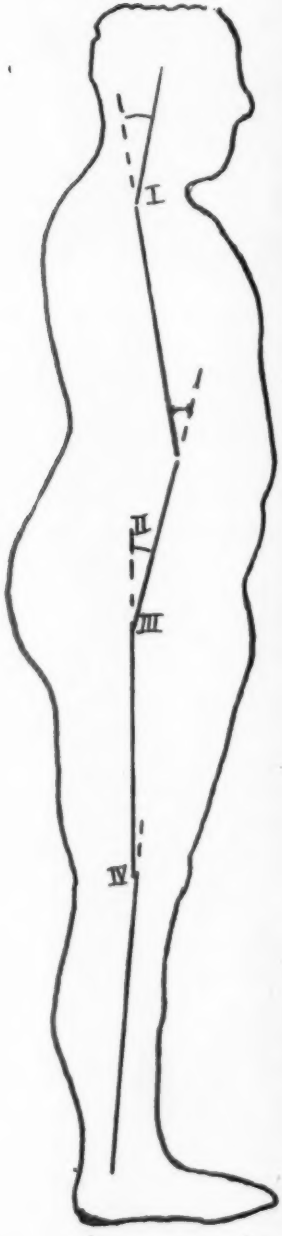

Figure II.

(Angle TGI.*)

Angle II.—Lines connecting the mid-point of the suprasternale spine line to the mid-point of the lumbale-abdominal line and to the trochanterion summum. (Angle GIF.)

Angle III.—Lines connecting the mid-point of the lumbale-abdominal line to the trochanterion summum and to the styloid process of fibula (mid-point of the knee joint). (Angle IFK.)

Angle IV.—Lines connecting the trochanterion summum to the mid-point of the knee and to the lowest point of the external malleolus. (Angle FKM.)

Angles I, II, III, and IV were measured and recorded in terms of deviation in degrees from a straight line. For example, if Angle I (TGI) were 170 degrees, it would lack ten degrees of being a straight line. The ten degrees were recorded. Another method of measuring Angles I, II, III, and IV is shown in Figure II. Here lines GI, IF, FK, and KM are extended as in the figure, and the resulting angles measured and recorded.

Other angles measured were as follows:

Line (BL)—Posterior trunk line measured with a vertical.
Line (SO)—Anterior trunk line measured with a vertical.
Line (GI)—Mid-trunk line measured with a vertical.
Line (SX)—Slant of sternum measured with a vertical.
Line (XO)—Sternum tip to os pubis measured with a vertical.
Line (LV)—Slant of sacrum measured with a vertical.
Line (IF)—Mid (LA) to femur measured with a vertical.
Line (OM)—Os pubis to malleolus measured with a vertical.
Line (OK)—Os pubis to center of knee measured with a vertical.
Line (FK)—Femur to center of knee measured with a vertical.
Line (VK)—Coccyx to center of knee measured with a vertical.
Line (VM)—Coccyx to malleolus measured with a vertical.
Line (KM)—Center of knee to malleolus measured with a vertical.
Angle (SCJ)—Suprasternale to cervical to chin.
Angle (TSB)—Tragion to suprasternale to spine.
Angle (CSB)—Costal angle.
Angle (TGS)—Head and neck angle.
Angle (TBS)—Tragion to back to suprasternale.
Angle (SXO)—Suprasternale to xiphoid to os pubis.
Angle (BLV)—Cervical to lumbale to coccyx.
Angle (OLA)—Pelvic inclination.
Angle (VOL)—Lumbale to os pubis to coccyx.
Angle (FKV)—Femur to mid-knee to coccyx.
Angle (FKO)—Femur to knee os pubis.
Angle (VMF)—Coccyx to malleolus to femur.
Angle (OMF)—Os pubis to malleolus to femur.

Deviations measured in millimeters were as follows:

1. Distance from malleolus to extended trunk line on foot.
2. Distance from acromion to vertical dropped from tragion.
3. Distance from great trochanter to vertical dropped from tragion.

* Letters refer to the angles measured; see Figure I.

4. Distance from malleolus to vertical dropped from tragion.
5. Depth of thoracic and lumbar curves on silhouettes.
6. Thoracic index (cord divided by depth of thoracic curve).
7. Lumbar index (cord divided by depth of lumbar curve).

The cords were measured from the inflection point of a line drawn from the cervical to the lumbale.

OTHER METHODS INVESTIGATED

Other measurements made upon the pictures were those of Kellogg, Goldthwait, and MacEwan-Howe.

1. The Kellogg Measurements: a) The head angle, b) the chest ratio, c) the pelvic obliquity.
2. The Goldthwait Measurement: the angle of deviation.
3. The MacEwan-Howe Measurements: the sum of the depths of the dorsal and lumbar curves, segmental angulation, and body tilt.

ANALYSIS OF THE DATA

The following data thus obtained were studied by methods of correlation.

Reliability of the Ratings

	r	±	P.E.
1. The composite ratings of the judges with the final criterion obtained with the method of paired comparisons	.910		.009
a) Intercorrelation between judges' ratings:			
Judge I with Judge II	.725		.027
Judge II with Judge III	.755		.020
Judge III with Judge I	.725		.027
b) Reliability of judges when stepped up by the Spearman Brown Prophecy formula	.893		.009
c) Reliability of the final criterion when the average odd ratings were correlated with the average even ratings	.990		.004

Objective Data With Criterion

	r	±	P.E.
1. The Kellogg Measurements:			
a) The head angle	.635		.027
b) The chest ratio	.530		.030
c) The pelvic obliquity	.720		.024
2. The Goldthwait Measurement: The angle of deviation	.710		.024
3. The MacEwan-Howe Measurements: The sum of the depths of the dorsal and lumbar curves; segmental angulation and body tilt; position of the head and neck.			

(The sum of these measurements as measured on silhouettes and weighted in the MacEwan-Howe regression equation.)	.580		.030
4. Measurements used in this study:	*r*	±	P.E.
a) Angle I, the angle formed by the lines drawn from the tragion of the ear to the mid-point of a horizontal line drawn from suprasternale to the spine and the mid-point bisecting a horizontal line drawn from the fourth lumbar vertebra to the abdomen. (Angle I, Figure II.)	.800		.017
b) Angle II, the angle formed by lines connecting the mid-points of the suprasternale-spine line, the mid-point of the lumbale-abdominal line, and the trochanterion summum. (Angle II, Figure II)	.935		.004
c) Angle III, the angle formed by lines connecting the mid-point of the lumbale-abdominal line, the trochanterion summum, and the capitulum of the fibula (landmark on the knee joint) (Angle III, Figure II)	.830		.017
d) Angle IV, the angle formed by lines connecting the trochanterion summum, the mid-point of the knee, and the lowest point of the external malleolus. (Angle IV, Figure II)	.330		.043
e) The sum of the above angles in degrees, Angle I + Angle II + Angle III + Angle IV.	.975		.004
5. Correlation with the criterion of additional measurement made upon the pictures (Figure I):			
Depths of Thoracic Curves from Line L.C.	.450		.036
Depths of the Lumbar Curves from Line L.C.	.340		.043
Thoracic curve index (cord divided by depth)	.310		.043
Lumbar curve index (cord divided by depth)	.390		.040
The distance from the malleolus to the extended trunk line (GI) measured at			

the level of the foot.	.216	.046
The distance from the tip of the great trochanter to a vertical dropped from the tragion.	.320	.043
The distance from the malleolus to a vertical dropped from the tragion.	.137	.048
The distance from the acromium to the vertical dropped from the tragion.	.013	.047

6. Correlation with the criterion of angles formed by lines drawn with a vertical (FIGURE I):

	r ±	P.E.
Line (BI)	.310	.043
Line (SO)	.233	.046
Line (GI)	.510	.036
Line (SX)	.041	.040
Line (XO)	.030	.047
Line (LV)	.003	.047
Line (IF)	.422	.040
Line (OM)	.010	.047
Line (OK)	.180	.045
Line (FK)	.326	.043
Line (VK)	.001	.048
Line (VM)	.003	.047
Line (KM)	.140	.046
Angle (SCJ	.167	.046
Angle (TSB)	.235	.043
Angle (CSB)	.366	.040
Angle (TGS)	.252	.043
Angle (TBS)	.296	.044
Angle (SXO)	.002	.047
Angle (BLV)	.030	.047
Angle (OLA)	.380	.043
Angle (VOL)	.063	.030
Angle (FKV)	.002	.047
Angle (FKO)	.001	.048
Angle (VMF)	.004	.047
Angle (OMF)	.138	.047

In view of the relatively small size of these correlations, as compared with the correlations of Angles I, II, III, and IV, and, the Kellogg, Goldthwait, and MacEwan-Howe measurements, it did not seem advisable to apply further correlation techniques to them.

INTER-CORRELATIONS

Elimination of measures were made on the basis of low correlation with the criterion and in favor of convenience and precision of measurement. The best measures were selected and intercorrelated by the Pearson Product Moment method. The following results were obtained between Angles I, II, III, and IV.

Angle I with Angle II	.618
Angle I with Angle III	.530
Angle I with Angle IV	.110
Angle II with Angle III	.833
Angle II with Angle IV	.250
Angle III with Angle IV	.300

Subject on Conformateur, Showing Landmarks

MULTIPLE CORRELATIONS

Multiple correlations were computed to determine combined values with the following results:

A. Measurements Developed in This Study:

Ro. 1234 = .985

Where: 0 equals the criterion
1 equals Angle I, head and neck-trunk alignment
2 equals Angle II, trunk-hip alignment
3 equals Angle III, hip-thigh alignment
4 equals Angle IV, thigh-leg alignment

The following regression equation gives the weighting of the items.

$$X_o = .089x_1 + .134x_2 + .067x_3 + .062x_4 - .35$$

THE POSTURE GRADE

The following table shows letter grades based upon the sum of the Angles I, II, III, and IV in approximate steps of one standard deviation above and below the mean.

TOTAL DEGREES ANGULATION AND EQUIVALENT POSTURE GRADES

Sum of angles I, II, III, IV	*Grades*
8° — 22°	A
23° — 36°	B
37° — 51°	C
52° — 65°	D
66° — 78°	E
79° — 93°	F

To obtain the posture grade measure Angles I, II, III, and IV, as shown in Figure II. Take the sum of the four angles as the posture grade.*

DISCUSSION

The Criterion.—The validity of a test depends upon the validity of an outside criterion with which is correlated the result or product of a test function or procedure. Erectness has been assumed to be the result of good anterior-posterior posture and relative straightness is usually associated with desired status. Posture as a product or function cannot at present be evaluated in terms of organic integrity since there are no well-established biological criteria with which to compare measurements of posture. We are forced, at present, to depend upon the subjective judgment of selected experts. The contention may be made, since posture evaluations are largely subjective, that no one knows enough about posture to make valid judgments. In answer, we must re-emphasize the fact that human judgment is universally involved to some extent in all measurement and that a consideration of posture obviously lies within the

* Since the sum of the angles correlated .97 with the criterion, and since the weighted items in regression equation only raised this correlation slightly, the extra work of computing the grade from the posture formula would not seem to be worth while.

ability of properly qualified people; and, that ultimately validity usually rests with the judgments of recognized authority.

The criterion developed for this study was reached through controlled expert opinion, planned scientific procedures, and the application of common sense. It may be stated for the particular rating procedures utilized here that they are in line with the best current practices in research and that the final criterion was determined from a comparative scale, in that postures were ranked by a comparison with median postures and not just each one rated without standards of comparison. Having established the scale, the process was extended by the method of paired comparisons. The relative statistical validity of the process is suggested by the fact that a fairly high correlation was obtained between the preliminary ratings of the three judges and the final criterion developed through the use of the method of paired comparisons.

Anatomical Considerations.—It should be noted that the measurements were chosen not only on the basis of high correlation with the criterion but also in favor of convenience of measurement and morphological continuity. The body as a flexible unit was divided structurally and functionally into what appeared to be measurable natural morphological segments: head, neck, trunk, hips, thigh, and leg. A continuous line drawn from the external malleolus to mid-femoral-tibial articulation approximately parallels the axis of the lower leg as a unit. Likewise the tip of the great trochanter may be taken as the upper end of the lower extremity and a line connecting the junction at the knee with the trochanterion practically parallels the long axis of the femur and bisects the thigh. While the trochanter to the mid-lumbar-abdominal line does not strictly represent a segment, the line approximately bisects the ilium in erect positions and functionally combines pelvic inclination, with lumbar concavity and abdominal protuberance. The line connecting the mid-points of the horizontal lines of the lumbar-abdominal and the suprasternale-thoracic-spine regions approximately bisects the trunk and parallels the long axis of the trunk segment. The line connecting the mid-suprasternale-thoracic spine to the tragus of the ear completes segmental continuity and in erect posture appears to approximately bisect the neck segment.

In the erect position the segments, head, neck, trunk, hip, thigh, and leg, form varying angles with each other and with the long axis of the body. (Fig. 1 and 2) The resulting angles, I (head-neck with trunk), II (trunk with hips), III, (hips with thigh), IV (thigh with leg) represent a continuity of structure and function and when measured in degrees of deviation from a straight line, give an accurate measure of segmental, regional, and total angulation. Since there exists continuity between segments, change of position

in one or more segments demands compensatory realignment in other regions, or involves the entire sequence depending upon the degrees of disturbance. High correlations of Angle II with the criterion would seem to establish hip and trunk alignment as a key relationship contributing most significantly to posture as measured in this study and influencing alignment in neighboring regions as is evidenced by high intercorrelations. This may be due to its central position in the sequence and the fact that knee and neck alignment are reflected in angulation of hip and trunk. Angle IV which has the lowest correlation with the criterion is a function of knee position, and is a part of Angle III which in turn correlated strongly with the criterion.

The Choice of Objective Methods.—Although authorities may differ as to what methods of grading anterior-posterior posture are most practicable for a certain situation, the choice of objective methods with adequate standards is not great. As a basis for comparison it is pointed out that the Kellogg, Goldthwait, and MacEwan measurements were correlated with the criterion developed for this study. It is therefore essential to present the evidence that the obtained coefficients of correlations Goldthwait (.71) and MacEwan and Howe (.560) are lower than the multiple correlations obtained with the method developed here with Angles I, II, III, and IV or with the Kellogg method. This evidence seems conclusive enough to recommend for use and further research the measures developed here or the Kellogg measures in the objective grading of anterior-posterior posture in men. It is further apparent that the methods investigated all measure something of the same postural characteristics, as is evidenced by the amount of agreement in the size of the correlations. The Goldthwait measure consists of a single angulation and is as yet unperfected since it does not cover certain postural variations; e. g., there are cases in which the lines do not intersect on the figure and others where the intersection occurs below the pelvic point. In addition, it should be noted that no procedure has been devised by which the mid-points on the body in the cervical, dorsal, and lumbar regions can be located conveniently and accurately. The MacEwan measurements were developed with particular reference to college women. It is possible that the postural characteristics of women may not conform exactly to standards and methods of measurement devised for men. It should further be noted that perhaps the various methods were not strictly comparable, since all comparisons were made on materials and data collected for this study. For example, no method was devised to insure that exactly the same relationships exist between measures taken on photographs and those taken on silhouettes.

Altogether, the method that proves to be the simplest and the

most accurate would seem to be preferable. The Kellogg measurements are taken with reference to definite vertical and horizontal axes; hence, considerable precision of measurement is necessary. In addition, the exact location of the symphysis pubis is often, in practical situations, a difficult and embarrassing procedure. On the other hand, Angles I, II, III, and IV are drawn from easily determined landmarks, are large enough to be measured accurately, and are not measured with reference to either a vertical or horizontal axis. Considerable latitude is therefore allowed for deviations in spinal curvature. Reasonable care must be taken in the drawing down of the angles upon the figure. Recordings are then made for each angle in terms of degrees of deviation from a straight line. For all practical purposes the sum of segmental angulation may be taken as the total segmental deviation and is recorded as the posture grade. The posture score may also be obtained through the use of the regression equation, which adds only slightly to the diagnostic value of the sum of the angles.

GENERAL SUMMARY AND CONCLUSIONS

The purposes of this study were: first, to review present standards of "good" and "poor" posture; second, to list and evaluate objective methods of measuring standing anterior-posterior posture; and third, to devise a usable and accurate objective method of measuring standing anterior-posterior posture.

In the literature related to posture there were many definitions of the correct upright position. At present, posture measurement is undergoing critical study and its limitations and possibilities are in the process of being clearly defined. However, when taken collectively, there seemed to be general agreement in the choice of criteria used to designate the conditions of "good" posture.

A review of the literature shows a number of methods of grading posture, though the choice of objective methods is not great. This study re-approached the problem and proposed to establish adequate objective standards for the grading of posture through objective measurements taken on silhouettes.

The following steps were involved in the investigation:

1. Silhouette pictures were taken of two hundred male students; a criterion was developed through the combined ratings of three qualified judges and through the further use of the methods of paired comparisons.
2. Selected measurements were made upon the pictures.
3. The chosen measurements were combined statistically and the posture formula expressed in regression form.

The results indicate that in the erect position the segments, head, neck, trunk, hips, thighs, and legs, form varying angles with each other and with the long axis of the body. The resulting Angles, I

(head-neck with trunk), II (trunk with hips), III (hips with thigh), IV (thigh with leg), when measured in terms of degrees deviation from a straight line, were found to be satisfactory as a measure of general and segmental poise. The best combination of these angles was found to measure posture as analyzed in this study up to a multiple correlation of .985.

The results further indicate that the Kellogg measurements, "the head angle," "the chest ratio," and the angle of "pelvic obliquity" as measured and combined here are fairly satisfactory as a measure of posture as analyzed in this study. Kellogg's best combination was found to measure posture up to a multiple correlation of .855.

Upon the basis of the evidence presented, the conclusion may be drawn that anterior-posterior posture as analyzed here may be measured accurately and objectively either by the Kellogg method or by the method presented in this study.

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A Simple Method of Testing The Physical Fitness of Boys

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In either peace or war one of the major problems of physical education is the measurement of physical condition; in a time of war when training programs are both important and necessary, it is essential that proper methods of determining the physical fitness of individuals be freely employed.

In war time we all realize the value of assessing the fitness of our troops. It should be evident that good condition is just as desirable in boys of high school age, who have more jobs and more responsibility than ever before, and who may have even more serious and more strenuous tasks in the near future. During this growth period physical defects should be corrected, and endurance, self-confidence, and skills should be developed. All these are the proper objectives of physical education programs. Physical fitness, by which we mean the ability to perform hard work in an efficient manner, can be developed by a proper physical education program. It cannot be evaluated by observing or testing a boy at rest; it demands that the boy be observed at work, and we should be interested in his ability to do really exhausting work. The test of physical fitness should measure a boy's ability to climb a mountain; it should determine how well he can "take it"; it should be a test of his dynamic state, when he is hitting on all cylinders; it need not be at all concerned with his condition at rest.

It is desirable that tests of physical fitness be given every boy who undertakes a program designed to improve his condition, not only to measure that boy's improvement but also to determine the efficiency of the program being offered him. Many tests of physical fitness have been designed for adults. For fitness for hard muscular work, the most reliable methods are based upon the principle that the rate at which the heart slows down after it has been accelerated by a standard hard exercise, gives an excellent measure of an individual's physical fitness. We all know that when we are in poor condition, our heart will beat very rapidly for a long time after we have climbed three flights of stairs, but if we are in good con-

This study was supported by a grant of the Carnegie Corporation.

dition, our heart will slow down very rapidly: this common observation will help to explain the principle of these tests and also what we mean by physical fitness.

Moderate exercise is unreliable in judging fitness because the difference between a fit and an unfit individual may not be apparent unless each is given a sufficient amount of exercise: at rest two boys may appear to be healthy and equally fit and following brief and mild exercise, little difference between them may be apparent, but after each has been given hard exercise vast differences in their fitness may be obvious.

Any type of general body exercise may be used in this test of physical fitness provided that (1) each subject works at a constant rate proportional to his size, (2) that the exercise requires no special skill, and (3) that the exercise utilizes his large muscles and, therefore, gives his heart, lungs, and blood vessels a great deal of work to do. A variety of exercise tests, all of which meet these conditions, have been satisfactorily used to estimate the physical fitness of hundreds of college students and secondary school boys. In our first attempts to use such tests upon younger boys, we found that the methods used for adults were not satisfactory, but a technique has now been developed which requires little equipment, no special technical skill in administration, and which permits the testing of large numbers of individuals within a short space of time.

Our preliminary tests showed that because of the wide range of size in boys between the ages of 12 and 18 years, it is desirable to divide all boys into two groups on the basis of their surface area: this was found to be more satisfactory than to make divisions on the basis of height or weight or age. Surface area, which depends upon both height and weight, is easily determined by means of a nomographic chart (Table A).* The exercise involved in the test we are describing consists in stepping up and down at the rate of 30 times a minute on a platform the height of which is 18 inches for the smaller boys and 20 inches for the larger boys. This exercise is carried on for four minutes unless the subject stops from exhaustion before then. The duration of the exercise is recorded. The heart rate is counted three times during the 3½ minutes after the exercise has ceased, and the physical fitness score is calculated by dividing the number of seconds of exercise by the sum of the three heart rates counted during the subsequent rest period. The higher the score, the fitter the boy.

This test requires only (1) that the boys' heights and weights be known, and that each one's surface area be determined so that he may be assigned to the proper height step; (2) that platforms of the proper heights be obtained; and (3) that a group of observers

* Tables A and B will be found on pages 29 and 30.

to count pulses be obtained. In our experience we have found that teachers or other adults very quickly become capable and accurate assistants in pulse taking, and the utilization of a large group of such helpers will permit the testing of many boys within a short time. Recently with the assistance of thirty teachers, one of us was able to test 600 boys in a little more than three hours.

It should be emphasized that only the heart rates during the recovery period following exercise need be determined. The initial heart rate, before exercise is started, need not be taken, and, furthermore, is not important. Research has shown that the initial heart rate of healthy young men does not have a significant relationship to an individual's physical fitness; his fitness depends on the rate at which his heart slows after exercise and not on how fast it may have been beating before he began to work. A boy who has a very slow heart rate before exercise but who is in poor condition will obtain a low physical fitness score because his heart, after speeding up during exercise, will not slow down quickly during the subsequent rest period. A boy who has a fast pulse before exercise but who is in good condition will get a good physical fitness score because his heart rate will slow down quickly after exercise. In neither case is the initial heart rate of any importance.

Fitness, as we define it, has nothing to do with any particular and specific strength or skill. What this test measures is the general capacity of the body to adapt itself to hard work and to recover from what it has done. The only skill which is required in the step test is a good coordination, which, in most instances, is part of the general fitness for hard muscular work.

DETAILED INSTRUCTIONS FOR THE STEP TEST OF PHYSICAL FITNESS FOR BOYS

A. Equipment:

1. A platform 20 inches high and a platform 18 inches high.
2. Stop watches or watches with second hands.
3. A nomographic chart to calculate surface area.

B. Procedure:

1. Measure the height and weight of each boy, and calculate each boy's surface area by means of the nomographic chart (Table A). Assign each boy whose surface area is less than 1.85 square meters to Group I; boys whose surface area is 1.85 square meters or more should be assigned to Group II.

2. Group I boys are sent to the 18-inch platform; Group II boys, to the 20-inch platform. Each boy stands at attention in front of his platform, and each boy is assigned to an observer who sits or stands beside him. A leader gives the signal "ready" and then the command "up." At the command "up," each boy places one foot on the platform, steps up so that both feet are on the platform,

straightens his legs and back, and immediately steps down again, one foot at a time. The pace is counted out by the leader: "Up-2-3-4, up-2-3-4" as in marching, the command "up" coming every two seconds. If a loud speaker system is available, a recording of the commands may be made and utilized. Subjects should not wear heavy shoes or ones with slippery soles. It is easier for the subject to lead off with the same foot each time and not try to alternate feet, but this can be done 2 or 3 times during the test if one leg gets tired.

3. The leader, and each observer if he desires, counts the time from the beginning of the exercise, and stops the exercise exactly at the end of 4 minutes. The observer must be sure that his subject steps fully on the platform and takes a standing position at each step up. No crouching should be allowed. The subject must keep the pace accurately and if he falls behind because he is tired, the observer must stop him after he has been unable to keep the pace for about 15 seconds. Should any boy become too fatigued before 4 minutes have elapsed, his observer should have him stop and he should record the duration of the boy's exercise.

4. At the end of 4 minutes' exercise, each boy should immediately sit down and remain quiet; the subsequent minutes are referred to as the recovery or rest period. The leader and the observer if he desires, notes the time, and exactly 1 minute after exercise has ceased, each observer begins counting his subject's pulse. The number of beats in the next 30 seconds are counted. When two minutes after the cessation of exercise have elapsed, the pulse is again counted for 30 seconds, and again at the end of 3 minutes after exercise. If each observer has a stop watch, he can start his watch at the beginning of the exercise, and can accurately determine the end of the exercise and the beginning of each of the pulse-counting periods. We have found it more practical to have the leader do all the timing and to give all the commands. The leader can start the exercise, give the commands, stop the exercise, and commence the beginning of each of the pulse-counting periods by giving the command: "Start counting!" Each observer should be instructed to locate his subject's pulse as soon as the boy has been seated after exercise: in this way he will become familiar with the boy's pulse before the beginning of the first counting period. It should be remembered that after hard exercise, it is easier to count the pulse in the neck, over the carotid artery; than at the wrist.

The full test is as follows:

Time	*Command*
0 minutes, 0 seconds	"Ready." "*Up*—2—3—4"
(Exercise continues for 4 minutes)	
4 minutes, 0 seconds	"Stop." "Sit down."
5 minutes, 0 seconds	"Start counting."

Time	*Command*
5 minutes, 30 seconds	"Stop counting."
6 minutes, 0 seconds	"Start counting."
6 minutes, 30 seconds	"Stop counting."
7 minutes, 0 seconds	"Start counting."
7 minutes, 30 seconds	"Stop counting."

C. The Calculation of the Score:

The three one-half minute pulse counts are added and the sum is multiplied by two in order to yield rates per minute. The duration of the exercise in seconds x 100 is then divided by the sum of the pulse rates, and the result is the physical fitness index.

$$\text{Physical Fitness Score} = \frac{\text{Duration of exercise in seconds x 100}}{\text{2 x sum of pulse counts, 1 to 1½, 2 to 2½, 3 to 3½ minutes of the recovery period.}}$$

Example: After 4 minutes of exercise a boy rests for one minute: his pulse beats are counted during the next 30 seconds and found to be 60; 2 minutes after exercise his pulse is again counted for 30 seconds, and this time there are 55 beats; 3 minutes after exercise the pulse is again counted for 30 seconds, and this time the number of beats is 50. The sum of these three counts, 165, is multiplied by 2 to convert to rates per minute. The duration of the exercise in seconds (240 seconds) x 100 is divided by 330; the result, 73, is the score (fractions are discarded).

It is suggested that each observer record his pulse counts on a card, and that he calculate each boy's score immediately.

Boys who become fatigued may have to be stopped before the end of the 4-minute period; their scores may be calculated as indicated above, using the actual number of seconds which the boy exercised in the numerator, and taking pulse counts as usual beginning one minute after he was stopped. We have found, however, that it is much easier and just as satisfactory to assign to all such boys the arbitrary score of "45." It has also become our custom to give the arbitrary score of "55" to all boys who lag behind or show other evidence of doing less work than is demanded by the test.

In order to facilitate the calculation of scores, a table has been devised. One need only obtain the sum of the actual pulse counts during the three 30-second periods and the score can be read directly. In the example given above, the sum of the three pulses: $60 + 55 + 50 = 165$ is referred to the table and the fitness index 73 is obtained (Table B).

D. Interpretation of Results:

This test, which requires the 18-inch and the 20-inch step and only a four-minute exercise period, has been designed specifically for testing boys between 12 and 18 years of age. The scores obtained

by the smaller boys on the lower platforms are of the same magnitude as those obtained by larger boys on the higher platform, and may be just as good scores as those obtained by larger boys; only the overweight boys are handicapped, and this is, of course, proper.

In testing boys of the 12-to-18-year age groups the standard given in Table C may be used. The figures at the right indicate the percentages of a group of over 600 private school boys, tested before a training period, falling into each category.

TABLE C

Score of 50 or less	Very poor physical condition	1.5%
Score of 51-60	Poor physical condition	18 %
61-70	Fair physical condition	50 %
71-80	Good physical condition	25 %
81-90	Excellent physical condition	4 %
91 or more	Superior physical condition	1 %

SUMMARY

For the purpose of determining the physical fitness of boys, a simple test, requiring little equipment and one which can be rapidly administered to large groups has been described. The greatest value of this test is that it permits the division of boys into groups on the basis of their fitness: the least fit may be separated from the fairly fit and from the very fit, and subsequently each of those groups can be given physical training appropriate to their degree of fitness. We all realize that boys whose fitness is poor must be given less work than other boys at first, and as their condition improves, the amount and severity of their physical training can be increased. It is equally desirable and necessary that the physical training given to boys whose fitness is good be appropriate to them; unless they are given a considerable amount of strenuous physical training, their fitness will not improve. On the basis of a boy's step-test score, he can be assigned to the type of physical training which is proper for him, and which will really benefit him. Without such a test, he will probably be given exercises which may either be too strenuous for him or so easy that he will not improve his fitness. We would like to emphasize the desirability of testing the physical fitness of all boys, and of retesting each boy following a proper period of physical training. Such testing will provide information for the boy's instructor, a score which will serve as an incentive to the boy, and a means of indicating what exercise and what games are the most efficient conditioners.

TABLE "A"

DUBOIS BODY SURFACE CHART

(As prepared by Boothby and Sandiford of the Mayo Clinic)

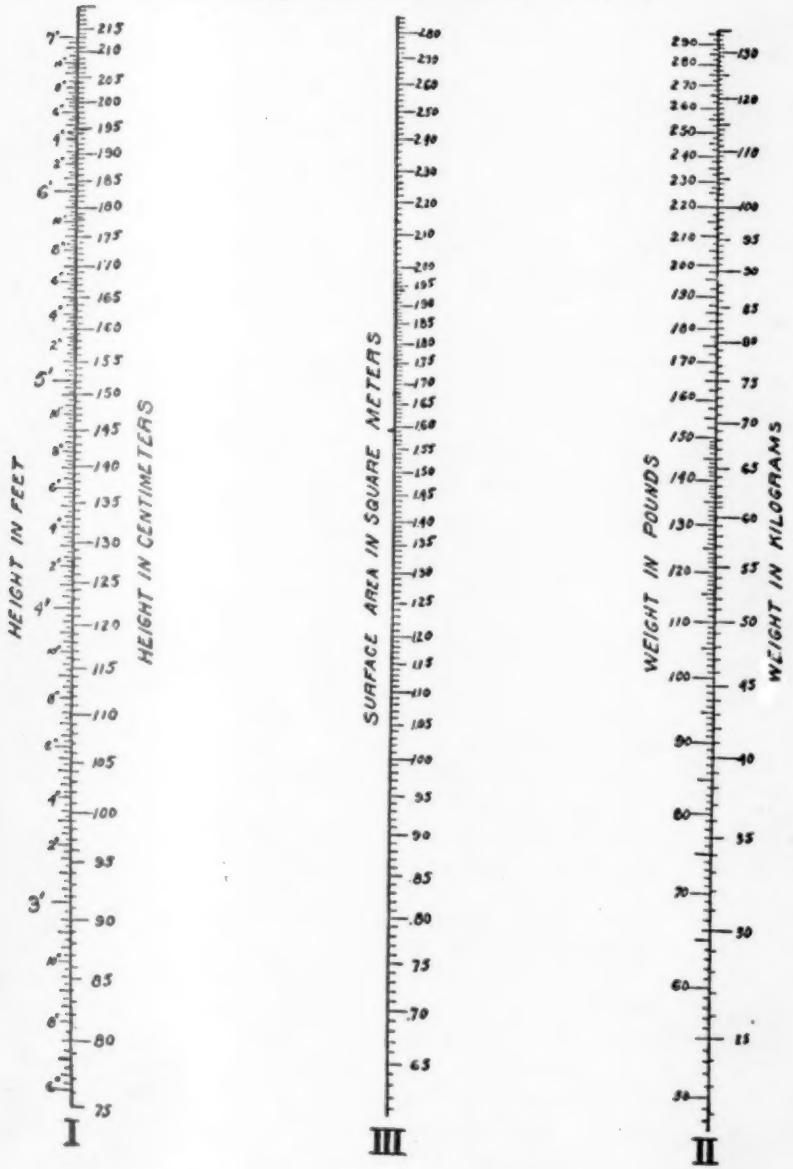

TABLE B

Pulse	*Score*	*Pulse*	*Score*	*Pulse*	*Score*
110	109	140	86	172	70
111	108	141	85	173	70
112	107	142	85	174	69
113	106	143	84	175	69
114	105	144	83	176	68
115	104	145	83	177	68
116	103	146	82	178	67
117	102	147	82	179	67
118	102	148	81	180	67
119	101	149	81	181	66
120	100	150	80	182	66
121	99	151	80	183	66
122	98	152	79	184	65
123	98	153	78	185	65
124	97	154	78	186	65
125	96	155	77	187–189	64
126	95	156	77	190	63
127	95	158	76	191	63
128	94	160	75	192	63
129	93	161	75	193	62
130	92	162	74	194	62
131	92	163	74	195	61
132	92	164	73	196	61
133	90	165	73	197	61
134	90	166	72	198	61
135	89	167	72	199	60
136	88	168	71	200	60
137	88	169	71	201	60
138	87	170	71	202–203	59
139	86	171	70	208	58

The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men

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TO become physically fit is an aim that should appeal to every normal young man. It is known that a satisfactory degree of physical fitness cannot be achieved except through an adequate training program and cannot be maintained if training stops.

It is obviously important to have a way of assessing physical fitness in order to classify unknown subjects into excellent, good, average, or poor groups, to follow the progress of a given subject during a training period, to check the adequacy of a training program, to reveal deterioration due to lack of training, staleness, illness, poor diet, etc.

Studies at the Harvard Fatigue Laboratory[1–6*] have shown that physical fitness for hard muscular work can be measured only if certain physiological reactions of the subject to hard work are known. Reactions to moderate work are unreliable because the easier the work, the less clear cut are the differences between the fit and the unfit.

A satisfactory estimate of a man's fitness can be obtained by exposing him to a standard exercise that no one can perform in a "steady state" for more than a few minutes and taking into account two factors: the length of time he can sustain it and the deceleration of his heart rate after exercise. For this purpose any type of exercise can be used provided that each subject works at a constant rate proportional to his body weight, that the exercise requires no unusual skill, and that the exercise puts the cardiovascular and the respiratory systems under real stress by involving large muscle groups.

It must be emphasized that physical fitness, as we use the term, has nothing to do with any particular strength or skill, although a certain amount of coordination is necessary to perform the present test properly. What this test measures is the general capacity of the body, in particular the cardiovascular system, to adapt itself to hard work and to recover from what it has done.

Various methods have been devised. The most simple is the

Address delivered at Springfield College (Springfield, Mass., Dec. 3, 1942.)
* Superior figures refer to bibliography at end of article.

Step Test[7] which consists in having the subject step up and down a 20-inch platform 30 times a minute for 5 minutes, unless he stops from exhaustion before then. The pulse is counted from 1 to 1½, 2 to 2½, and 3 to 3½ minutes after the work stops. The score is obtained by dividing the duration of exercise by the sum of pulses in recovery according to the formula:[6]

$$\text{Index} = \frac{\text{Duration of exercise in seconds} \times 100}{2 \times \text{sum of pulse counts in recovery}}$$

The meaning of the figure thus obtained is as follows: below 55 = poor physical condition; from 55 to 64 = low average; from 65 to 79 = high average; from 80 to 89 = good; above 90 = excellent.

As many men can be tested every 10 minutes as observers to count pulses are available. Figure I* summarizes some of the results that were obtained in applying this method. The figure shows the scores of freshmen when entering college and after twelve weeks of training (four hours a week). The following points are illustrated:

1. The test picks out the best, the average, and the worst men in a group of unknown subjects.

2. Comparison of the scores in June with the scores in September indicate the effect of training.

3. Some students deteriorated during that period as indicated by a second score lower than the first. These men were excused from regular exercise on account of illness or minor injuries.

4. It is seen that the progress made by the low group is more marked than that made by the good group. This indicates that the training program was adequate for the unfit but not hard enough for many of the fit men.

The average score for the Harvard College population at large (2,200 students) irrespective of training condition is 75 with a range from 15 to 120. The average for the freshman class in June was 69 and in September, after training, it improved to 76. Varsity and Junior Varsity athletes score above 90 when in full condition.

The Step Test therefore is useful in picking out men of approximately equal fitness and in training them adequately and more rapidly because they make a homogenous group. If a group contains both poor and superior physical specimens, the training cannot be adequate. It will be either too stiff for the poor or too easy for the good. By giving a quantitative measure of the state of training of a certain group, this method indicates whether or not the intensity of the training should be increased in order to attain a higher degree of fitness. Experiments on over 700 college students

* Figure I will be found on page 36.

and college athletes have shown that the highest average physical fitness is obtained when an adequate training program is given to men of approximately the same physical fitness.

Very high degrees of fitness can only be achieved by men who have the necessary qualities and are submitted to a regular and intensive training program. Even in the best men, fitness cannot be maintained if training stops.

As far as we know, this type of test is the only one which has been described for measuring general physical fitness for hard work in normal, healthy men. In our experience, other tests previously known (Schneider, McCloy, McCurdy-Larson) are useful in detecting various failures of the cardiac and circulatory mechanisms, but they are not always reliable for assessing fitness for hard work in healthy individuals. The scores they give do not necessarily correspond with the actual performances of the subjects and there is little or no correlation between these scores and the present index.

It is worth mentioning that only the heart rates during the recovery period following exercise need to be determined. The initial heart rate before exercise is not important for the purposes of the test. Studies have shown that the heart rate before exercise is usually not related to an individual's physical fitness.[8]

This test gives results comparable to those obtained with more complicated techniques previously described, such as the treadmill test and the bicycle ergometer test, and it is based upon the same physiological principles.

It should be realized that the general procedure of the test has been simplified to make it most practical. Results as accurate as those obtainable with more elaborate laboratory techniques therefore cannot always be expected. A difference of a few points in the score between two well-trained athletes does not mean much. But large amounts of data prove conclusively that the test can be used successfully in scoring general fitness and in following the change of fitness in a given individual.

METHOD

This test requires no special equipment and permits the simultaneous testing of a large number of individuals within a short span of time. A platform, bench, or wall will serve as the "step." The observers should be provided with stop watches.

Each subject stands at attention in front of the platform. Each observer stands behind his subject. At the signal *up,* the subject places one foot on the platform, steps up placing both feet fully on the platform, straightens his legs and back and immediately steps down again, one foot at a time. The pace is counted by one of the observers: *Up*-2-3-4, *Up*-2-3-4, as in military marching, the command *up* coming every 2 seconds. It is easier for the subject to

"lead off" with the same foot each time and not try to alternate the feet but this can be done 2 or 3 times during the test if one leg gets tired.

The observer begins counting the time when the subject starts. The exercise is kept up for 5 minutes continuously unless the subject stops from exhaustion before then. The duration of the exercise is recorded.*

When the subject stops he sits down. The observer notes the duration of the exercise and records the pulse from 1 to 1½, 2 to 2½, and 3 to 3½ minutes after the subject stops working. The actual number of heart beats during each 30-second period is recorded. It is easiest to count the pulse in the neck (carotid pulse) where the beats are stronger than at the wrist after exercise.

If there is only one stopwatch available, one observer is put in charge of giving all signals from the start until the end. At his commands, the other observers count the pulses at the usual intervals during recovery. In this case if a subject cannot finish the 5-minute exercise, his pulse is not taken and he is given an arbitrary score.

CALCULATION OF THE SCORE

Add the three ½-minute counts of the pulse and multiply by two. Divide the duration of exercise in seconds x 100 by the sum of the pulses.

In order to simplify the calculation, a table has been computed which gives directly the scores for all who finish 5 minutes. Add the actual number of heart beats counted during the three 30-second periods in recovery and read the score directly. For example, if a man finishes 5 minutes and his pulse from 1 to 1½ is 75; from 2 to 2½ is 65; from 3 to 3½ is 60, the sum of pulses is 200, and reading from the table the score is 75.

Unless a precise score is desired for the subjects who do not finish 5 minutes, mean scores have been calculated on the basis of 5 time categories as follows:

Duration	*Score*
Less than 2 minutes	25
From 2 to 3 minutes	38
From 3 to 3½ minutes	48
From 3½ to 4 minutes	52
From 4 to 4½ minutes	55
From 4½ to 5 minutes	59

For comparative purposes, the mean score of the time category involved is arbitrarily assigned to a subject who performs the work for that particular duration.

* The observer must be sure that the subject steps fully on the platform and takes a standing position at each step up. No crouching should be allowed. The subject must keep the pace accurately and if he falls behind because he is tired the observer must stop him after he has been unable to keep pace for 10 or 15 seconds.

TABLE OF SCORES FOR 5-MINUTE PERFORMANCE*

Pulse	*Score*	*Pulse*	*Score*	*Pulse*	*Score*
100	*150*	129	116	172–173	87
101	149	*130*	*115*	174–175	86
102	147	131–132	114	176–177	85
103	146	133	113	178–179	84
104	144	134	112	*180*–181	83
105	143	135	111	182–184	82
106	142	136	110	185–186	81
107	140	137–138	109	187–188	80
108	139	139	108	189–191	*79*
109	138	*140*	*107*	192–193	78
110	*136*	141–142	106	194–196	77
111	135	143	105	197–198	76
112	134	144	104	199–201	*75*
113	133	145–146	103	202–204	74
114	132	147	102	205–206	73
115	130	148–149	101	207–209	*72*
116	129	*150*	*100*	*210*–212	71
117	128	151–152	99	213–215	70
118	*127*	153	98	216–218	*69*
119	126	154–155	97	219–222	*68*
120	*125*	156–157	96	223–225	*67*
121	124	158	95	226–229	66
122	123	159–*160*	*94*	*230*–232	*65*
123	122	161–162	93	233–236	64
124	121	163	92	237–239	63
125	120	164–165	91	*240*–243	*62*
126	119	166–167	90	244–247	61
127	118	168–169	89	248–*250*	*60*
128	117	*170*–171	*88*		

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* The first column refers to the sum of the actual pulse counts during the 30-second periods from 1 to 1½, 2 to 2½, and 3 to 3½ minutes. The second gives the corresponding scores.

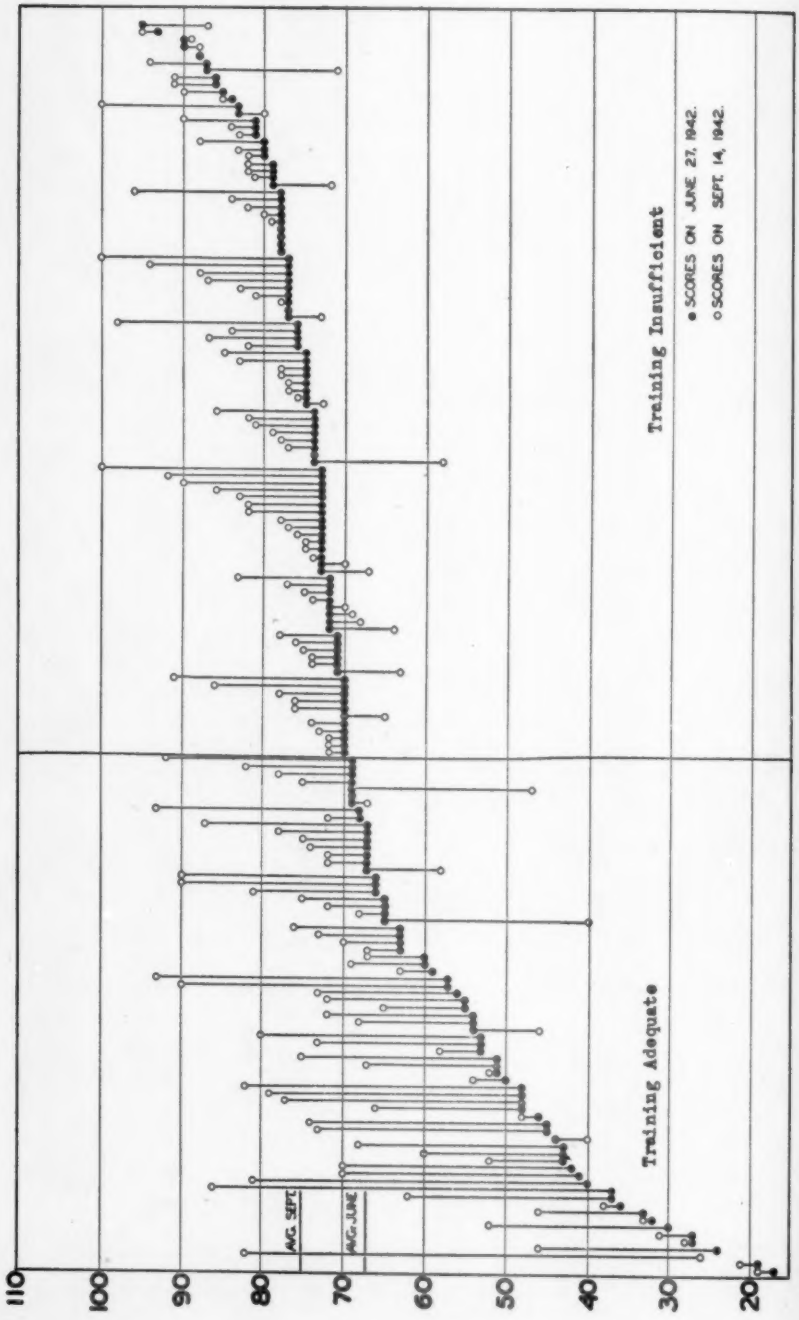
Training Insufficient
Training Adequate
• SCORES ON JUNE 27, 1942.
○ SCORES ON SEPT. 14, 1942.
AVG. SEPT.
AVG. JUNE
110
100
90
80
70
60
50
40
30
20

FIG. I

A Study of the Development of Textbooks in Physiology and Hygiene in the United States

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INTRODUCTION

THE purpose of this study was to trace the development of the purposes, content, organization, and teaching aids found in the textbooks in the field of physiology and hygiene which were printed in the United States between the years 1800 and 1941. This necessitated a search of bibliographical compilations in order to determine what textbooks had been published in the field.

Because many more books were published in physiology and hygiene during the twentieth century than in the nineteenth, and also because many more were available for analysis, it was considered necessary to make a selective sample for the twentieth century. This sampling was made on the following four bases: (1) the extent to which the textbook was used in the period in which it was written, that is, its popularity in the schools; (2) the grade level for which it was written according to the author's statement (an effort was made to get a cross section of all grade levels); (3) the revisions of the books during the period of this study. a revision being considered a means by which changes in philosophy or practice could be traced; and (4) the decade in which the books were written, so a relatively even distribution of books over the 41 years of this century could be made. Next came an analysis of all available nineteenth century books and the selected twentieth century books from the qualitative and quantitative aspects of their contents and an interpretation of the same.

Organizing the relevant data concerning the development of physiology and hygiene textbooks and drawing comparisons between the changes during the nineteenth and twentieth centuries constituted another phase of the general problem. Also, an important part has been the classification of the data according to appropriate chronological divisions and subject-matter groupings and topics.

The writer wishes to express her gratitude to Dr. John A. Nietz for encouragement, sympathetic understanding, and helpful criticism given during his direction of this study. She is also indebted to the members of the thesis committee for valuable suggestions.

Gratitude is felt toward a number of other persons for their suggestions and assistance in the development of materials. These include Miss Bertha V. Leifeste and Miss Rena M. Carlson of the staff of Clarion State Teachers College, Mrs. Samuel Wilhelm of Clarion, Mr. W. W. Livengood of the American Book Company, and Mr. John Barnes Pratt of the A. S. Barnes and Company.

FIG. I

Since textbooks have figured so vitally in the educational history of the United States and since the development of texts in physiology and hygiene has been a phase in the evolution of educational history which has been uninvestigated for the most part, an analysis of materials in this field should discover information which should contribute to the broadening of our knowledge in the historical evolution of American textbooks.

The following were the chief sources of data employed in this study. An excellent collection of early American physiology and hygiene textbooks was found in the private library of Dr. John A. Nietz, of the University of Pittsburgh. This furnished 56 nineteenth century textbooks. In addition, some old texts were found in the Plimpton Collection at Columbia University; the science and technological division and "Rare Bookroom" of the Library of Congress, the library of the Office of Education in Washington, D. C.; and in the Michigan State Historical Library at Lansing, Michigan. Modern texts were available in the departmental collections of several colleges and universities. Nineteen twentieth century books were used, which made a total of 81 books analyzed in the study.

ANALYSIS OF THE TEXTBOOKS

A. Aims of Authors

Diversification of aims was characteristic of the eighteen hundreds, while standardization of objectives around a few major points has been a development of the nineteen hundreds. Seventy-four aims were found expressed in the prefaces of the nineteenth century books, which were embodied in 205 statements. In the twentieth century, there were 30 aims expressed in 57 statements in the prefaces of the texts. Further analysis indicated that the latter aims were grouped around three points, namely, (1) to keep the child informed about the latest scientific information in the field of medical research; (2) to furnish him with practical information in order that a healthier individual and citizen could be produced; and (3) to furnish him with the opportunity for practice of habits which would be physiologically and hygienically sound.

Physicians, who wrote about 80 per cent of the texts of the nineteenth century, saw the times in the light of their medical training, while the educators who wrote the greater percentage of twentieth century textbooks expressed a different philosophy in their aims.

B. Organization and Presentation

Various plans of presentation of the textual materials have been used by American authors of physiology and hygiene textbooks. The selection of form appeared to rest with the individual writer, and in the early years of the nineteenth century little similarity was found; each author wrote to meet school and home situations as he viewed

them. It was found that the following plans were used: the allegorical in three books, the catechetical in two books, the comparative in seven books, the deductive in 20 books, the inductive in 44 books, the "analytic-unific-synthetic" in two books, and the static-dynamic in one book. These were in turn subdivided into smaller units as the chapter, section, lesson, division, part, and units.

The use of the deductive plans developed during the early years of social reform when the instillation of principles seemed foremost in the minds of leaders. The development of the inductive plan, and its increasing popularity over one hundred years, paralleled the spread of Pestalozzi's ideas in America. The use of the unit plan in the most recent texts was a belated outgrowth of the Herbartian and Morrison philosophy which was reflected in texts of other fields at an earlier date.

C. Subject-Matter Content

A topical analysis was made of the subject-matter content under 21 headings. These were as follows: alcohol, narcotics, and stimulants; alimentary system; animal heat; circulatory system; excretory system; exercise, fatigue, and rest; food and nutrition; glandular system; muscular system; nervous system; respiratory system; skeletal system; skin and membranes; directions for nurses and sick; disease; emergency and accident; growth and development; moral education; reproductive system; sex education; and miscellaneous materials, such as medical reports and the like.

In the nineteenth century the nervous system far surpassed all others mentioned in the total amount of page space devoted to it. This was followed by the skeletal, alimentary, respiratory, and circulatory systems in that order. The three topics which ranked the lowest in the amount of total page space during the nineteenth century were those on moral education, directions for nurses and sick, and the reproductive system. Sex education received no space allotment as a topic in the work of authors of the last century.

Twentieth century authors did not follow the same pattern in the use of page space. Disease ranked first in this period with 13 per cent of the total page space devoted to it. This was not as much as was given to the nervous system which led the previous century, but it was the highest for the present period. The nervous system came second, followed by the topics of food and nutrition, the respiratory system, and the alimentary system as the first five in order. Sex education, directions for nurses and the sick, and the glandular system were the topics which received the least attention of writers of our century. The reproductive system which ranked with the lowest topics of the last century did not have any space devoted to it as a topic in our period. The space devoted to accident and emergency rose from less than one per cent to that of approximately seven per

cent in the twentieth century. The respiratory system was the only topic which maintained its relative position in the mean percentage of page space given to it in the two centuries.

Personal hygiene was studied by means of 14 topical headings which were as follows: bathing; bedding; clothing; exercise and rest; habit formation; care of hair, nails, and skin; illness; lacing; nutrition; posture; care of the special senses; teeth and breath; waste products; and mental factors. It was found that personal hygiene occupied four per cent of the total page space of nineteenth century textbooks and increased to 11 per cent of the total page space in our century.

There were 11 topics analyzed in public hygiene, namely, better housing, disease control, disinfection, disposal of garbage, disposal of sewage, legal physicians, pure foods and drugs, ventilation of public buildings, water and milk purification, occupational hygiene, and recreation. Of these topics, ventilation of public buildings was by far the most popular in the eighteen hundreds, while disease control surpassed all the others in the nineteen hundreds. Public hygiene was not a particularly popular subject among authors of the last century for they devoted only about one per cent of their total page space to this field, but in our century a definite change was noted by the increase of total page space to that of 15 per cent.

D. Visual Aids

American authors of physiology and hygiene textbooks have used pictorial aids in their books since about 1834, when Dr. Alcott's book, *The House I Live In,* was published.

We have been inclined to consider visual aids as a somewhat recent innovation in textbooks and have prided ourselves upon their newly found educative values. However, this analysis has revealed that the nineteenth century textbooks also carried a high pictorial load, in some instances even higher than that found in books of our own century. Hitchcock, for example, in 1861 included 373 illustrations on 251 different pages, which accordingly gave his book the highest load found in both centuries.

Toward the latter part of the nineteenth century, better processes for the production of illustrative materials for textbooks were developed, namely, the photomechanical means of making pictures. Improved results were noticed from the beginning of the twentieth century until in the most recent text included in this study (1941) there was found the acme of illustrative work from an artistic viewpoint.

Preference for certain topical subject matter in which visual aids were inserted was noted in both centuries Writers of the nineteenth century selected the nervous system as the topic which was to receive

TABLE I

DATA SHOWING THE COMPARISON OF NUMBER, PERCENTAGE, RANGE, AND AVERAGE NUMBER OF PAGES FOR ALL ANALYZED TEXTBOOKS ON EACH TOPIC IN SUBJECT-MATTER CONTENT

Topic	Total Number of Pages for all Textbooks	Range for all Textbooks	Average Number of Pages per Textbook	Percentage of Total Pages
Nineteenth Century				
Alcohol, Narcotics, and Stimulants	832.5	0-83	13.4	5.54
Alimentary System	1429.0	0-72	23.0	9.52
Animal Heat	267.0	0-22	4.3	1.78
Circulatory System	1184.5	0-45	19.1	7.89
Excretory System	130.5	0-28	2.1	0.87
Exercise, Fatigue, and Rest	380.0	0-82	6.1	2.53
Food and Nutrition	601.0	0-51	9.7	4.01
Glandular System	115.0	0-24	1.8	0.76
Muscular System	1137.5	0-49	18.3	7.58
Nervous System	3382.5	0-132	54.5	22.53
Respiratory System	1363.5	0-52	21.9	9.08
Skeletal System	1271.5	0-74	20.5	8.47
Skin and Membranes	756.0	0-56	12.2	5.04
Directions for Nurses and Sick	35.0	0-9	0.5	0.23
Disease	243.0	0-49	3.9	1.62
Emergency and Accident	92.0	0-52	1.4	0.61
Growth and Development	302.0	0-37	4.9	2.02
Moral Education	86.5	0-20	1.4	0.58
Reproductive System	46.0	0-46	0.7	0.31
Sex Education	0.0	0-0	0.0	0.00
Miscellaneous	1356.0	0-133	21.8	9.03
Total	15011.0			100.00
Twentieth Century				
Alcohol, Narcotics, and Stimulants	264.5	0-36	13.9	4.90
Alimentary System	425.5	0-51	22.4	7.83
Animal Heat	50.5	0-18	2.6	0.90
Circulatory System	297.0	0-36	15.6	5.47
Excretory System	62.5	0-10	3.3	1.15
Exercise, Fatigue and Rest	288.5	0-63	15.2	5.32
Food and Nutrition	482.0	0-60	25.4	8.86
Glandular System	17.5	0-5	0.92	.33
Muscular System	185.0	0-22	9.7	3.42
Nervous System	672.5	0-83	35.4	12.39
Respiratory System	400.00	0-48	21.0	7.37
Skeletal System	213.0	0-28	11.2	3.93
Skin and Membranes	273.5	0-52	14.4	5.07
Directions for Nurses and Sick	6.0	0-6	0.31	.11
Disease	725.5	0-126	38.1	13.37
Emergency and Accident	321.5	0-40	16.9	5.94
Growth and Development	293.5	0-54	15.4	5.42
Moral Education	57.0	0-24	3.0	1.05
Reproductive System	0.0	0-00	0.0	0.00
Sex Education	19.0	0-12	1.0	.35
Miscellaneous	370.5	0-185	19.5	6.82
Total	5425.0			100.00

their concentration of pictorial attention, while authors of our century considered the topic of disease the most important from an illustrative viewpoint. Some topics varied little in the number of pictures allotted them in the span of fourteen decades, and others were found to be almost entirely neglected throughout the study.

Visual aids served two primary purposes: as a means of pupil clarification and as a subject of topical recitation. Pictorial material has been plentiful in American physiology and hygiene textbooks, and if one may judge from its continued use for about 117 years, it has been on the whole a desirable adjunct to subject-matter content in this branch of science.

E. Teaching Aids

American authors of physiology and hygiene textbooks have done their best to influence teaching procedures. As educational methods changed, the authors outlined experiments for teacher-demonstrations and told teachers how and why models and specimens should be used in their work. Around the 1920's, teacher direction by authors became less pronounced than was true for almost 100 years preceding that date.

By means of the various sections of the textbook, that is, preface, introduction, etc., the authors have extended the possibilities of the textbook as a teaching-learning tool.

Questions and footnotes were synonymous in the early eighteen hundreds, since the question occupied the footnote space. Later the placing of questions was changed, first to the back of the book and then to the end of short book sections as chapters or lessons, and the true function of the footnote began to evolve. Questions were an important part of the textbook in the days when teacher training had not developed and teacher certification was based more upon religious qualifications than scholastic propensities.

Tables of contents and indexes were, likewise, synonymous in the early books. Over 14 decades, there was a tendency toward the simplification of both of these from the more elaborate forms found in earlier books. The value of these two sections as aids to learning was well appreciated by all authors. Summaries, references, glossaries, and appendices were included or not, as the writers saw fit. The appendix was a catch-all for information of various types which the authors thought should be included.

The realization that vocabulary was an important factor in the learning process was sensed by almost all authors, and by printing these technical terms in italics and including glossaries an effort was made to aid the pupil in selecting the more important terms for concentrated study.

Authors' suggestions for testing pupil knowledge were in the main confined to two methods, the catechetical and the recapitulatory forms. Objectivity in this matter was not considered by authors of either century. Keys to anatomical charts included in the body of the textbook were found in the back of the book for a short time. For a period of about two decades between 1852 and 1874 these keys and suggestions for their use seemed to answer a need of pupil recitation by topical assignments.

F. Mechanical Construction

Durability, attractiveness, and economy in the printing of books have been the major problems of textbook publishers since early times. Physiology and hygiene textbooks proved to be no exception to this troublesome question.

An increase in the demand for textual material came about 1850-1860, when physiology and hygiene as a school subject grew in popularity in the school program. To meet this need the factor of economy entered in and, thereby, attractiveness was sacrificed. Cardboard and later cloth bindings replaced the leather; poorer, non-absorbent paper was substituted, which made the print of some textbooks almost illegible. Advertisements decorated the cardboard covers instead of the gold striping found on the backs of some leather-bound texts. Thus, the first efforts of the publishers toward increased production resulted in texts of poorer mechanical construction than those of earlier years. The turn of the nineteenth century saw a trend toward improvement, however.

Desire for economy cheapened the book; durability brought about the development of machine-made books and better paper; and attractiveness, coupled with legibility, perhaps forced the greatest changes found in either century in the way of page arrangement, typography, margins, and changes in interlinear distance.

CONCLUSION

Textbooks in physiology and hygiene written by American authors began to be published about 1830. Before that time, importations came from France, Germany, and England, or translations of foreign books were printed in this country. American writings in the field of physiology and hygiene appeared to have been stimulated by four factors: the drift of religious thinking away from strict ascetic doctrines of the church after the Revolutionary War; the rise of public interest in education and, hence, in what subject matter was contained in the school curriculum; the efforts of educational leaders like Horace Mann to broaden the content of the school program; and the influence of Pestalozzian principles upon our educational philosophy.

One of the early textbooks for children in the field of physiology and hygiene was *The House I Live In,* by William Alcott, which is now in the "Rare Bookroom" of the Library of Congress.

Aims of nineteenth century authors were varied, indeed, while those of the twentieth century authors became more uniform. In their effort to popularize physiology and hygiene, authors used diverse means to reach the general public, the parent, the teacher, and pupil. When these subjects became incorporated in the curriculum by law after the 1880's, a greater standardization of aims was possible and advisable.

The inductive plan of presentation was by far the most popular among American writers in physiology and hygiene. Other plans were used, but this proved to be the choice of the largest percentage of authors. Organization of material centered around the chapter plan with the part plan ranking second and used as a means of drawing chapters together around a chosen unit of study, as the circulatory system for example.

Nineteenth century writers concentrated their work upon the anatomy, physiology, and hygiene of the bodily systems, with the nervous system ranking very high in each period. Authors of our century paid less attention to systems but more to factors resulting from the functioning of these systems, as disease, nutrition, and cleanliness. Personal and public hygiene and the term health appeared in titles of textbooks after the World War of 1917-18, but the subject-matter content remained essentially physiological and hygienic in nature with merely a change of title and emphasis.

Personal hygiene stressed the use of proper clothing and sufficient exercise in both centuries, while public hygiene content concentrated upon pure water and milk, and pure food and drugs.

Professional ethics in regard to recognition of source materials and support for scientific information were on a fairly high plane in both centuries. This may have been true because a large percentage of the early authors were physicians who were trained in ethical procedures.

Visual aids were found in physiology and hygiene textbooks from 1834 to 1941. Their most common use was about 1861 when the illustrative load of textbooks was higher than at any other time during the study. On the whole, page-space ratio of subject matter topics and allotment of illustrations to topics agreed rather well.

Illustrations were at first wood engravings and later photomechanical. Improvement was noted in sharpness of line and the artistry of the pictures. Titles were placed below the illustrations in the majority of cases.

Writers of both centuries endeavored to help the teacher and pupil in the interpretation and use of their texts. Through the

preface, introduction, and footnotes they tried to offer hints which would help the teacher conduct the recitation or experiment or show the pupil how to use a topical outline for review. Teaching-learning aids were numerous; and the inclusion of glossaries, indexes, and summaries by many authors facilitated the use of the text to an even greater extent. Physiology and hygiene authors were solicitous, indeed, of the users of their books.

Vocabulary difficulty of American textbooks in physiology and hygiene was found to be high throughout this study. Most nineteenth century texts ranked far too high in vocabulary difficulty for the grade level for which the authors stated they were written. Twentieth century texts improved somewhat but were still not found to be well graded as to vocabulary use.

Leather covers were used for many early textbooks; but, as the demand for more and cheaper books increased, these were replaced with cardboard and then cloth covers. Attractiveness of format and bindings improved after the nineteenth century when research studies showed the advantageous factors of print size, interlinear space, and line length, as well as color and format. No uniformity was shown in the mechanical construction of early textbooks as each printer was a law unto himself, but today's textbooks meet hygienic standards of typography, leading, and length of line used in the book.

The Relation Between the Learning of a Motor Skill And Measures of Strength, Ability, Educability, and Capacity

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STATEMENT OF THE PROBLEM

THE problem under investigation in this study consisted of determining the relation between the learning of a motor skill and measures of strength, motor ability, motor educability, and motor capacity. Essentially the study was threefold in nature: 1) it was concerned with securing measures of individual differences in learning a motor skill; 2) expressing these differences in the form of components of the learning curve, namely, initial status, rate of learning, and maximum learning peaks; and 3) determining the relationships between these differences and the factors of strength, motor ability, motor educability, and motor capacity.

HISTORICAL BACKGROUND

The last fifteen years in the profession of health and physical education have produced considerable research on the evaluation of abilities in light of recognizing and providing for individual differences. Numerous tests have been constructed for the purpose of classifying students into homogeneous groups with the result that this area has been well covered by Kistler,[1] McCloy,[2] Cozens,[3] Bookwalter,[4] and others. However, such measures have depended for the most part upon values of present status, i. e., age, height, weight, coordination, strength, and various other combinations.[5] Curricula in physical education have made great use of such research but have proceeded upon the basis that once individuals have

Abstract of study submitted in partial fulfillment for the degree of Doctor of Philosophy in the School of Education, New York University.

1 J. W. Kistler, "The Establishment of Bases for Classification of Junior and Senior High School Boys into Homogeneous Groups," *Research Quarterly*, 8, (1937) p. 11.

2 C. H. McCloy, *The Measurement of Athletic Power* (New York: A. S. Barnes and Company, 1932) p. xiv, 178.

3 F. W. Cozens, *Achievement Scales in Physical Education Activities for College Men* (Philadelphia: Lea and Febiger, 1936).

4 K. W. Bookwalter, "A Critical Evaluation of Some of the Existing Means of Classifying Boys for Physical Education," *Research Quarterly*, 10, (1939) p. 119.

5 L. A. Larson and W. A. Cox, "Tests and Measurements in Health and Physical Education," *Research Quarterly*, 12, *Supp.* (1941) p. 483.

been classified into relatively homogeneous groups, adequate responses in learning situations may be obtained. What appears not to have been recognized as an essential factor is that although initial abilities may be similar, rates of learning and maximum learning peaks differ and vary widely within the same group.

Fundamentally, it would appear that there is a discrepancy between educational philosophy and practice. Educational philosophy contends that learning, and therefore education, is a dynamic process.[6] This process is always in motion, but the product may be evaluated by obtaining a measurement of an individual's status at any particular moment in time. When interpretations are made, they are made on the basis of fragmentary evidence, while the entire background of the situation is obscure. More than in any other field do teachers of physical education have need of some type of cumulative index whereby students might be appraised from the point of view of improvement in basic motor qualities over a period of time. This type of record is available, in part, to other academic fields through a process of elimination whereby only the majority of those fit and able to pursue a higher education attend such centers of learning. Transcripts are available which may be sent to any part of the country. An individual glancing through such a transcript, immediately visualizes a picture of the student's entire background. On the other hand when a student reports for a physical education class for the first time, beyond a knowledge of his age, height, and weight, he is an unknown quantity. Whether his physical development has been retarded or influenced by illness still remains a hidden fact, although this may be revealed by inspection of the medical record, should one be available. Perhaps the individual has reached a peak of physiological development so that it is impossible for him to move his muscles any faster, to jump any higher, or throw any further. Perhaps he has never had an opportunity to participate in coordinated motions required in physical education activities. To classify this individual with, let us say, thirty other people, who are also unknown quantities except for the information obtained on a classification test amounts to taking one pound of gold ore, one pound of platinum ore, and one pound of lead ore, and saying, since they are equal in weight, the outcome of processing this material four weeks hence, will yield the same results. The problem of evaluating learning abilities has been recognized by McCloy,[7] Cozens,[8] Larson,[9] and

[6] H. H. Horne, *The Democratic Philosophy of Education* (New York: The MacMillan Company, 1936) p. xxiii, 547.

[7] C. H. McCloy, "Some Unexplored Areas for Research," *Research Quarterly*, 10 (1939) pp. 3-10.

[8] F. W. Cozens, "The Determination of the Efficiency of Group Learning Under Different Incentive Conditions and Modes of Activity," *Research Quarterly*, 4 (1933) pp. 50-62.

[9] L. A. Larson, "A Factor Analysis of Motor Ability Variables and Tests, With Tests for College Men," *Research Quarterly*, 12 (1941) pp. 499-517.

others, but the recent publication of Brace[10] concerning the identification of factors involved in learning motor skills and the development of tests to measure such factors appears to be the opening wedge for such research.

Essentially then, the present investigation was undertaken with the express purpose of furnishing objective data that might identify measures associated with qualities basically involved in learning motor skills.

PROCEDURE

Selection of Motor Skill.—The fencing lunge was selected as the motor skill for the following reasons: 1) it represents a bodily movement in which comparatively few individuals have had previous experience; 2) improvement in the skill may be measured objectively by the use of precision instruments; and 3) the skill offered an excellent opportunity to observe the development of new muscular patterns, since its execution contains four important qualities, strength, speed, coordination, and accuracy. Of the four, speed and accuracy lent themselves most readily to objective measurement.

Measurement of Improvement in the Skill.—A device originally designed by E. R. Elbel,[11] but modified for the present investigation, was employed in order to measure improvement in the accuracy and speed of the fencing lunge. The apparatus consisted of an electrified target, a control cabinet, and an electric clock measuring time in 1/1000 of a second. It was wired in such fashion that the moment the operator released the starting switch, a signal light flashed and the electric clock began to operate. The impact of the foil not only flashed the accuracy of the lunge, but broke the electrical circuit operating the clock and thus indicated the speed with which the lunge was performed.*

Tests of Physical Status.—Four test batteries were selected because they presumably offered an insight into the learning characteristics of individuals. McCloy's motor capacity test was chosen since it reputedly measures a general type of potential motor development and suggests a theoretical maximum that appears to be associated with the maximum peak of a learning curve. The Johnson motor educability test was selected on the basis of evidence indicating that it is the best available measure that may be associated with the slope of the learning curve. Larson's indoor motor ability test was selected because it measures stages of motor ability and because it appears to be related to the initial stage of a learning curve. The

10 D. K. Brace, "Studies in the Rate of Learning Gross Bodily Motor Skills," *Research Quarterly*, 12 (1941) p. 181.

11 E. R. Elbel, "A Study of Response Time Before and After Strenuous Exercise," *Research Quarterly*, 11 (May, 1940) pp. 86-95.

* Because of limited space, complete data on the construction and wiring of the apparatus have not been included. Additional information may be obtained by writing to the investigator, City College of New York, who will gladly forward all necessary material.

Rogers' strength test was selected because of the value of strength as a basic factor in the performance of motor skills.

The Experimental Group.—The subjects used in this investigation consisted of a group of eighty-seven male students selected at random from the required physical education classes of the City College of New York. The group was heterogeneous from the point of view of socio-economic status, nationality, intelligence and attitude, and interest in physical education, but was relatively homogeneous with respect to the number of years of school experience. Moreover, all subjects who had had any previous experience in fencing were excluded, since a practical zero point of experience in the skill was desired.

Collection of Data.—Using the previously described subject group, each one of the test batteries was administered according to standardized instructions. A total of five weeks was required to complete this aspect of the testing, with the McCloy test given first, followed in order by the Rogers, the Larson, and the Johnson tests. Appointments were made with the subjects for specific days and hours.

The experimental group met twice a week for twelve weeks for purposes of training and instruction in the fencing lunge, with each weekly period of forty-five minute duration. Each subject was tested once a week for the total period of twelve weeks. At each testing period, five or six preliminary lunges were utilized as a warm-up and the subject was then asked to start the trials. Ten trials were permitted; the accuracy scores and the speed scores were averaged separately and then transcribed to a large posting sheet where all subjects might see their weekly scores.

TREATMENT AND ANALYSIS OF THE DATA

Construction of Learning Curves.—It is important to emphasize that the present investigation was directed toward a description of individual differences involved in the learning process, rather than attempting to account for factors and reasons underlying learning *per se*. Accordingly, the first broad problem consisted of analyzing the data obtained over a period of twelve weeks, so that an answer might be supplied for the question, "What does the shape of the learning curve look like?" Two approaches were used: the first approach assumed that there was some generalized law in operation tending to influence the data in such a way as to produce a curve typical of the learning function. In this case it was a question of selecting a second degree parabola, a log-log curve or any one of a number of curves commonly encountered in learning experiments. The second approach was based upon a preliminary examination of the data with the express purpose of proceeding upon the information divulged from such statistical analysis.

Since the concept of individual differences was of paramount importance, three elements were selected by which these differences might be distinguished, namely, initial status, rate of learning, and maximum learning at the end of the experimental period. Several mathematical techniques were capable of yielding such information but it appeared important to select a technique that was related logically to the data at hand. Hence, two methods were examined, the Courtis technique[12] and the freehand method. The Courtis technique was selected because it uses the Gompertz equation and curve as the function underlying growth; the freehand method was used in the event that the Courtis technique was found to be inadequate. Of the two methods, the freehand was chosen for reasons presented in the following section.

Reasons Underlying the Technique Employed.—Means and sigmas were computed for both speed and accuracy scores for each of the twelve-week testing periods and Pearson product moment coefficients were computed between successive weekly periods; that is, the correlation between the first and second week was determined, then the correlation between the second and third, and so on. The means were used to determine the progress of learning for the entire group, the measures of variability yielded an analysis of the relative weight ascribed to portions of the learning curve and the successive weekly correlations were computed in order to ascertain the degree to which the group tended to level off. It was reasoned that as individuals reached a peak of learning and development, the degree of association existing among the scores would tend to become high. These results are contained in Table I.

TABLE I

MEASURES OF CENTRAL TENDENCY VARIABILITY AND SUCCESSIVE CORRELATIONS BETWEEN WEEKLY PERIODS

Period	Accuracy			Speed*		
	Mean	Sigma	r	Mean	Sigma	r
1st	49.63	12.20		0.760	.0579	
2nd	57.97	10.27	.658	0.707	.0644	.677
3rd	61.99	8.13	.583	0.664	.0603	.648
4th	65.09	6.91	.624	0.644	.0566	.834
5th	67.25	6.46	.603	0.627	.0564	.872
6th	69.00	5.50	.761	0.613	.0564	.874
7th	71.38	4.47	.726	0.596	.0551	.875
8th	72.62	4.96	.829	0.588	.0490	.908
9th	72.90	4.43	.899	0.586	.0504	.965
10th	73.23	4.69	.928	0.578	.0491	.939
11th	73.78	4.83	.949	0.573	.0496	.930
12th	75.07	4.68	.936	0.561	.0491	.961

*Scores recorded in 1/1000 second.

12 S. A. Courtis, *The Measurement of Growth*, (Ann Arbor, Michigan: Brumfield and Brumfield, 1932) p. ii, 155 (mimeographed).

Turning first to the accuracy scores, the values of sigma and *r* obtained for the tenth, eleventh, and twelfth weeks were considered extremely significant. During this specific time interval, the sigmas as well as the correlation coefficients are approximately equal. This apparently confirmed the use of the above-mentioned procedures and indicated that some type of maximum development had occurred. Because of the slight numerical differences, the question then arose as to whether these differences were statistically significant or had occurred because of chance fluctuations. Hence some expression of the relationship between sigmas and coefficients was needed. The following principle appeared to offer just such solution. *Individual differences in learning cannot be measured when the correlation coefficients of successive time intervals are equal and when the sigmas of the same time intervals are equal.* While such statement presumably suggested a reason for the similarity of numerical values among these statistical values, rigorous mathematical proof was lacking. Such proof was developed by assuming that the correlation between the differences of successive correlations would be equal to zero only if chance errors were involved. Since chance errors are uncorrelated, a numerical value of zero would indicate the absence of any other experimental factors tending to produce such differences.* On the basis of this evidence it was possible to combine the scores of the last three weeks into one score, that represented maximum learning. Thus, one of the factors essential in describing individual differences was obtained, namely, maximum learning peaks.

The sigmas of the first two weeks were large relative to succeeding ones. This constituted evidence that they failed to represent reliable initial points for learning rates. It should be remembered that no individual in the experimental group had had any previous experience in the fencing lunge. Therefore, the sigmas should have been theoretically the same for the first two weeks and thereafter should have become larger as individual differences manifested themselves. However the large variance obtained at the initial stage includes factors of previous training and experience in skills involving similar bodily movements, and hence, unduly affects the rate of learning of those who have lower starting points on the learning curve. It was for this very reason that the Courtis technique was not found to be completely adequate. In many cases when the Courtis technique was applied, the percentages of development at the very beginning of the experiment were found to be high, in some cases as high as 45 per cent. This fact tended to obliterate the bottom portion of the Gompertz curve and resulted in a segment of

* A complete mathematical treatment and development of this proof is contained in a paper, as yet unpublished, written by Dr. Raymond Franzen and the investigator.

the total curve. Furthermore, curves of individuals starting fairly low, continuing with a large gain the subsequent week, and thereafter proceeding at a slow rate of learning were overweighted because of the necessity of fitting a line to the data. Apparently the information regarding the rate of learning based on such overweighting would tend to obscure much of the actual evidence. Hence the scores of the first two weeks were combined to represent the initial status, but were not included in the rate of learning calculations. In this way, the second independent factor, initial status, was obtained.

The scores within the period extending from the third to the ninth week were then used to compute the third factor necessary for distinguishing individual differences, rates of learning. The speed scores were treated in exactly the same fashion and the following summarization is presented.

1. The speed and accuracy scores were treated separately in order to uncover as much information as possible.

2. Three elements were selected by means of which individual differences might be distinguished: initial status, rate of learning, and maximum end points.

3. Two methods of constructing learning curves were investigated: the Courtis technique, and the freehand method.

4. The results of the preliminary statistical analysis disclosed the fact that the Courtis technique was not applicable to the present study.

5. The analysis yielded satisfactory independent measures for each of the above-mentioned factors describing differences.

6. Examination of the speed score showed first, that there was a definite group of improvement; second, that individual differences decreased with practice; and third, that individuals tended to maintain the same relative positions throughout the experiment.

7. The speed scores yielded essentially the same results; a definite group improvement, decrease in individual differences, and a *status quo* in positions thereafter.

Having once eliminated the Courtis technique, learning curves were constructed for each of the eighty-seven subjects by the method of Least Squares.[13]

Relation between Measures of Physical Status and Components of the Learning Curve.—Correlations between components of the learning curves and the test batteries were obtained by means of the Pearson product moment method. These results are contained in Table II. In the case of accuracy there is very little or no relation between initial status and the four test batteries. Furthermore the one item that presumably might show a fair degree of association

[13] C. C. Peters and W. R. Van Voorhis, *Statistical Procedures and Their Mathematical Bases.* (New York: McGraw-Hill Book Company, 1940) p. 426.

with initial status, the Larson test, provides no insight into the initial portion of the learning process.

TABLE II

THE RELATION BETWEEN MEASURES OF PHYSICAL STATUS AND COMPONENTS OF THE LEARNING CURVE

	Accuracy			Speed		
	Initial Accuracy	Rate of Learning	Maximum Development	Initial Accuracy	Rate of Learning	Maximum Development
Physical Fitness	—.079	.176	.423	.352	.048	.107
Motor Ability	—.087	.073	.456	.403	—.006	.090
Motor Educability	—.074	.195	.515	.567	.101	—.216
Motor Capacity	.078	.144	.672	.513	.017	.127

The same inference appears to hold true for the small relationships existing among the batteries and rates of learning. In spite of evidence pointing to the validity of the Johnson test as a diagnostic instrument for measuring rates of learning, it would seem that the results of this study confirm Brace's statement, namely, that tests of educability do not satisfactorily measure this aspect of learning.[14] All four test batteries show a consistent, high degree of association with maximum learning, with McCloy's test showing the highest coefficient, .672. Of all four, only the McCloy test purports to measure potential, so that within the scope of this study, individuals achieving a high motor capacity score tend to achieve high terminal learning points.

Referring next to the material on speed, it may be seen that all four test batteries correlate fairly well with initial status. While the correlations are not to be considered high they indicate the existence of relationships to a greater extent than do the correlations between rates of learning and the test batteries, and maximums and test batteries. In the latter, the obtained numerical values are so low as to be insignificant. However a very interesting and pertinent bit of evidence is revealed in the relation between initial status and batteries. The McCloy test ranks second to the Johnson test. The question may then be raised as to why the McCloy test should correlate highly with maximum peaks in the case of accuracy and correlate in similar fashion with initial status in the case of speed. As a matter of fact this apparent inconsistency is not an inconsistency but rather evidence of a confirmatory nature since it supplements the data contained in Table I. There it was shown that individuals who possessed initial high qualities of speed tended to remain fast and improve throughout the duration of the experiment, while those who were initially slow at the beginning also improved, but maintained

[14] D. K. Brace, "Studies in the Rate of Learning Gross Bodily Motor Skills," *Research Quarterly*, 12, (1941) p. 65.

their position of relative slowness. It would appear then, that the factor of total bodily speed required in the learning of a complex motor skill may be evaluated in terms of the degree of speed the individual possesses at the very inception of the learning process. Furthermore, both the McCloy motor capacity test and the Johnson educability test appear to contain possibilities for distinguishing individual differences when a skill demanding speed of bodly movement is taught. This interpretation should be carefully evaluated because speed as determined in this study was influenced by the accuracy required for the performance of the fencing lunge. There is always the possibility that pure speed of bodily motion, that is, speed free of inhibiting influences, might have presented a different picture of individual differences when correlated with the test batteries.

Partial and Multiple Correlation Analysis of the Learning Curves.—Before investigating the net importance of each test battery in relation to the learning process, logic compelled a summarization of measures of central tendency and variability of the specific items. These results are contained in Table III but do not throw any additional light on the problem.*

The interrelationships among the test batteries were also analyzed and in this case some significant information was brought to light. (See Table IV.) The high relation between the Johnson educability test and the McCloy motor quotient furnishes some basic explanation for the manner in which they are associated with maximum learning peaks and initial status. A correlation coefficient of .710 is regarded as significant and it is quite possible that the two

TABLE III

MEASURES OF CENTRAL TENDENCY AND VARIABILITY FOR COMPONENTS OF THE LEARNING CURVE AND TESTS OF PHYSICAL STATUS

	Mean	Sigma
Accuracy		
Initial Status	53.91	1.04
Rate of Learning	1.85	1.20
Maximum Learning	73.94	0.46
*Speed**		
Initial Status	710.94	53.63
Rate of Learning	89.33	31.80
Maximum Learning	43.90	27.39
Test Batteries		
Physical Fitness	67.15	16.40
Motor Ability	451.47	90.66
Motor Educability	51.77	13.16
Motor Quotient	94.92	7.75

*Speed recorded in 1/1000th of a second

* These data are included so that any subsequent studies of similar nature may have a basis for comparison of results.

TABLE IV

TEST BATTERY INTERCORRELATIONS

	Motor Quotient	Motor Educability	Motor Ability
Physical Fitness	.635	.418	.738
Motor Ability	.689	.428	
Motor Educability	.710		

tests may be used interchangeably. However it should be noted that this high relation is spurious since the McCloy test contains a measure of motor educability, the Brace Iowa test. But in light of evidence reported by Gire and Espenschade,[15] the relation between the Brace Iowa test and the Johnson test is but .202, so that the spurious overlapping still does not account for the high association between the McCloy and Johnson tests. The marked relation between the physical fitness index and the Larson motor ability test merely adds one more bit of evidence to the already lengthy list of strength-testing studies, namely, that physical fitness offers a reliable predictive index of motor ability.

Since the zero order correlations between the learning curve for accuracy and speed and the four test batteries yielded significant correlations on separate components of the curves, partial and multiple techniques were applied to maximum learning points in the case of accuracy and initial points in the case of speed. It was apparent that the other associations existing between segments of the two curves were so small as to make the application of partial and multiple techniques meaningless.

Analysis of Terminal Accuracy and the Tests.—The results of the partial and multiple correlation computations are contained in Table V. The zero order correlation between terminal learning

TABLE V

PARTIAL AND MULTIPLE CORRELATION COEFFICIENTS FOR THE ACCURACY LEARNING CURVE AND THE FOUR TEST BATTERIES*

First Order Partial Correlations					
$r12.3$	=	.502	$r13.4$	=	.399
$r14.3$	=	.304	$r15.4$	=	.145
$r15.3$	=	.265	$r23.4$	=	.641
$r24.3$	=	.603	$r35.4$	=	.169
$r25.3$	=	.523	$r12.5$	=	.576
$r13.2$	=	.072	$r13.5$	=	.408
$r14.2$	=	—.013	$r14.5$	=	.236
$r15.2$	=	—.007	$r23.5$	=	.635
$r34.2$	=	—.119	$r34.5$	=	.196
$r35.2$	=	—.060	$r45.2$	=	.542
$r12.4$	=	.558	$r45.3$	=	.683

*1. Terminal accuracy. 2. Motor capacity. 3. Motor educability. 4. Motor ability. 5. Physical fitness.

15 E. Gire and A. Espenschade, "The Relationship Between Measures of Motor Educability and the Learning of Specific Skills," *Research Quarterly*, 13, (1942) p. 45.

Second Order Partial Correlations			
$r12.34$ =	.418	$r45.23$ =	.540
$r15.34$ =	.083	$r12.35$ =	.442
$r25.34$ =	.192	$r14.35$ =	.175
$r13.24$ =	.071	$r24.35$ =	.394
$r15.24$ =	.000	$r13.25$ =	.072
$r35.24$ =	.005	$r14.25$ =	—.011
$r14.23$ =	—.005	$r34.25$ =	—.104
$r15.23$ =	—.002		
Third Order Partial Correlations			
$r12.345$=	.411	$r14.235$=	—.004
$r13.245$=	.071	$r15.234$=	.000
Multiple Correlation Coefficient			
$R1.2345$ = .674			

points and the motor quotient is .672. When educability is held constant, the relation between maximum points and the McCloy test ($r12.3$) drops to .502, indicating that the factor of educability plays a significant role in this aspect. The residual partial correlation nevertheless indicates a substantial correlation remaining between terminal end points and motor capacity. In other words, McCloy's test is an important factor in distinguishing levels of potential learning when educability is partialled out. When both educability and motor ability are held constant the original correlation of .672 is decreased to a value of .418, implying that motor ability has some importance in distinguishing potential learning peaks. Its relative importance is not as great, however, as that of educability. When all three factors of educability, motor ability, and strength are held constant, ($r12.345$) the original correlation is lowered to .411 which is but .007 units less than the value obtained when only educability and motor ability are held constant, (.418). Thus, it would appear as though the strength test does not add materially in describing individual differences in learning. The persistence of a relationship of approximately .400 between motor capacity and terminal end points when all factors are held constant, supplies confirmatory evidence of the importance of motor capacity as an integral factor in learning motor skills.

Analysis of Initial Speed and the Tests.—Practically the same interpretive picture is presented when the partial and multiple correlations for the speed learning curves are examined, except that in this case motor educability plays the predominant role. (See Table VI.)

When motor capacity is held constant the net relation between initial points ($r13.2$) and motor educability drops from a zero order coefficient of .567 to .337. When motor ability alone is partialled out ($r13.4$) the net association is .476 and varies but slightly when the strength index is held constant, with a value of .491. When both

TABLE VI

PARTIAL AND MULTIPLE CORRELATION COEFFICIENTS FOR THE SPEED LEARNING CURVE AND THE FOUR TEST BATTERIES*

First Order Partial Correlations			
$r12.3$ =	.192	$r13.4$ =	.476
$r14.3$ =	.217	$r15.4$ =	.089
$r15.4$ =	.154	$r23.4$ =	.641
$r24.3$ =	.603	$r35.4$ =	.170
$r25.3$ =	.531	$r12.5$ =	.400
$r13.2$ =	.337	$r13.5$ =	.491
$r14.2$ =	.080	$r14.5$ =	.227
$r15.2$ =	.040	$r23.5$ =	.635
$r34.2$ =	.120	$r34.5$ =	.196
$r35.2$ =	.061	$r45.2$ =	.542
$r12.4$ =	.356	$r45.3$ =	.683
Second Order Partial Correlations			
$r12.34$ =	.078	$r45.23$ =	.540
$r15.34$ =	.008	$r12.35$ =	.131
$r25.34$ =	.205	$r14.35$ =	.155
$r13.24$ =	.331	$r24.35$ =	.387
$r15.24$ =	—.004	$r13.25$ =	.335
$r35.24$ =	—.005	$r14.25$ =	.070
$r14.23$ =	.043	$r34.25$ =	.103
$r15.23$ =	.020		
Third Order Partial Correlations			
$r12.345$=	.078	$r14.235$=	.038
$r13.245$=	.332	$r15.234$=	—.003
Multiple Correlation Coefficient			
$R1.2345$ =	.590		

*1. Initial Speed. 2. Motor Capacity. 3. Motor educability. 4. Motor Ability. 5. Physical Fitness.

motor capacity and motor ability are held constant ($r13.24$) the residual remaining between motor educability and initial status is .331. When all three factors ($r13.245$) are held constant, the remaining value is .332.

This evidence would seem to indicate that motor capacity affects the relation between motor educability and initial status to a substantial degree. Such an inference appears to be warranted from two points of view. First, the zero order correlation between motor educability and initial status may be accepted as indicating a high degree of association because of the complexity of factors entering into the experimental procedure. It would be unreasonable to assume that psychological factors such as boredom, lack of interest or motivation, would tend to be low one day and high the next and thus produce a correlation indicative of a higher relationship. Second, the fact that the elimination of motor capacity decreases this zero order correlation (.567) to .337 certainly demonstrates the importance of this variable as an adjunct of motor educability. When the multiple correlation coefficient is examined,

($R1.2345$) it is apparent than an R of .590 yields but little more information over and above the zero order value of .567. Hence it may be concluded that motor educability alone offers as good a determinant of initial status on a learning curve as does a combination of motor educability, motor capacity, motor ability, and strength.

Analysis of Initial Speed and Maximum Learning in Terms of the Four Tests.—In order to complete the analysis of the two learning curves, partial and multiple correlations of speed and accuracy

TABLE VII

PARTIAL AND MULTIPLE CORRELATIONS FOR SPEED AND ACCURACY WITH THE FOUR TEST BATTERIES*

First Order Partials					
$r13.2$	=	.607	$r23.1$	=	.388
$r14.2$	=	.402	$r24.1$	=	.475
$r16.2$	=	.338	$r25.1$	=	.289
$r15.2$	=	.363	$r26.1$	=	.234
Multiple Correlations					
$R3.12$	=	.731	$R5.12$	=	.522
$R4.12$	=	.656	$R6.12$	=	.473

*1. Accuracy.
2. Speed.
3. Motor capacity.
4. Motor educability.
5. Motor ability.
6. Physical fitness.

together were computed with each one of the test batteries. These results are shown in Table VII.

The multiple coefficients sum up the previous sections in succinct form and offer adequate bases for interpretations of relationships existing among components of the learning curve and the tests. Not only do they show that the tests rank in relatively the same order of importance, but they further characterize the contributions of both motor capacity and motor educability when a learning situation is utilized as a criterion of interpretation.

DIGEST OF FINDINGS

When improvement in the accuracy of a total body movement is used as a criterion of learning, the experimental evidence obtained in this study warrants the following conclusions.

1. Individual differences in accurately coordinated body movements decrease with training and instruction.

2. Measures of strength, motor ability, motor educability, and motor capacity are not related to either initial status or rates of learning.

3. Measures of strength, motor ability, motor educability, and motor capacity show varying significant relations with maximum learning points, the Roger's test correlating .423, the Larson test,

.456, the Johnson test, .515, and the McCloy, .672, with this segment of the learning curve.

4. On the basis of a multiple correlation coefficient of .674, the McCloy test provides as good an insight into maximum learning potentials of individuals as does a combination of all four test batteries.

When improvement in the speed of a total body movement is used as a criterion of learning, the evidence points to the following conclusions:

1. Individual differences with respect to speed of body movement decrease with training and instruction.

2. A point in the learning curve is reached whereby the differentiation of individuals on the basis of speed is almost impossible. This point exists only after enough time has elapsed for the individual to adequately adjust and learn muscular patterns involved in the skill, and when the distance through which the body moves is not more than thirty inches.

3. Measures of strength, motor ability, motor educability, and motor capacity show varying significant relations to initial points on the learning curve.

4. Measures of strength, motor ability, motor educability, and motor capacity are not related to either rates of learning or maximum learning peaks in speed of movement.

5. The multiple correlation coefficient of .590 indicates that the Johnson test provides as much information about initial starting points as does a combination of all four tests, but does not imply that it may be used as a reliable index of the initial portion of the curve.

When accuracy and speed are taken together as the learning process, an analysis of each one of the tests provides the following conclusions:

1. McCloy's motor capacity test is a satisfactory diagnostic instrument for evaluating potential learning when both accuracy and speed of muscular movements are involved in a motor skill.

2. The Johnson motor educability test is less efficient than the McCloy test in distinguishing individual differences in learning.

Activities Engaged In By Teachers of Physical Education in The High Schools of Illinois, Part II

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PURPOSE

IT WAS the purpose of this study to learn certain facts regarding physical education in the high schools of Illinois, which might be helpful in the re-evaluation and strengthening of the teacher-training curriculum in that area at the university. An earlier article[1] discussed other information secured by this study, including the duties of teachers of physical education, the activities included in the curriculum, and the sports coached by these persons.

The present article will portray the situation with respect to facilities and equipment, personal data, training, and self-evaluation of this training. The conclusions will include a condensed summary of those reached in the earlier report.

PROCEDURE

Over one thousand inquiry blanks were sent to the high schools listed in the Illinois School Directory for 1939-40. Four hundred and forty schools, or 45 per cent responded. A school enrollment of more than 150,000 students, 1,000 teachers of physical education, and 440 principals are represented by the data. The enrollment groupings used in the presentation were as follows: Group A, up to 50 pupils; Group B, 50-99; Group C, 100-249; Group D, 250-499; Group E, 500-999; Group F, 1,000-1,999; and Group G, over 2,000.

DISCUSSION

In a previous study[2] on the junior high school level, 60 per cent of the principals who responded "did not consider the present curriculum in physical education as complete and worth while as the other curricula in (their) schools, largely because of lack of equipment, proper facilities, time, organization, and administration . . ." The replies which follow indicate the opposite, since the majority of the high school principals felt they had both adequate facilities and adequate equipment.

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1 C. O. Jackson, "Activities Engaged in by Teachers of Physical Education in the High Schools of Illinois," *Research Quarterly*, 13:2 (May, 1942), 242-251.

2 C. O. Jackson, "Physical Education in the Junior High Schools of Illinois," *Research Quarterly*, 10:1 (March, 1939), 124-134.

Requirements of time range from none whatsoever (subject not taught) to three hundred minutes a week, including one or two health periods, or one safety period, or a combination. The majority of schools require physical education for graduation, and six to eight semesters, depending on whether the school is a three- or four-year senior high school. (See Table I.)*

Most schools have two periods a week devoted to physical education, and some add a third class period for health or safety, or both. The majority have only part-time teachers of physical education (i. e., they teach academic subjects in addition to physical education and coaching) but as the school increases in size, there is a trend toward hiring full-time teachers in this area. Health and safety are commonly included as part of the physical education curriculum.

In September, 1941, all but twelve of the thousand high schools in Illinois provided at least two years of courses in physical education for their students. Since that time, many now offer a third, or a fourth year.

There is even greater variation in the matter of facilities. Slightly more than half of the smallest schools have gymnasia, but as the enrollment increases above fifty pupils, most have such facilities. In schools with an enrollment above two hundred, gymnasia are indicated in every instance. As might be expected, very few schools have swimming pools, although some may have access to community or institutional pools during specified periods in the winter months. The data on facilities will be found in Table II.

The reaction of the principals concerning the question of the adequacy of facilities and equipment is interesting. Two hundred and eighty indicated adequate facilities for conducting the program in physical education, while fifty-six conveyed a negative answer. Almost one hundred administrators failed to reply to this question. Three hundred and fifty-five principals stated they had adequate equipment, while twenty-four said they did not. Sixty-one failed to answer this question.

Principals from all of the smallest schools gave affirmative answers to both questions. As the school increased in size, there was a noticeable tendency to state that facilities were inadequate. Many principals said they were doing as well as could be expected under the present situation.

Perhaps the chief reason why the administrator of the small school is satisfied with the program of physical education is that little time, money, and effort are devoted to it. A multiple-teacher, already weighed down with a heavy load of acadamic teaching, can usually devote only one or two twenty-five minute periods a week

* Tables I through XIV will be found at end of article.

to "organized" play for the entire student body. Team sports, usually softball and basketball receive most of the emphasis, and little or no attention is given to grade placement, to individual differences, and to needs and interests of the pupils. In all too many cases, both principals and teachers make no distinction between the "in-class" program in physical education, and the "out-of-class" varsity sports program. Where this is true, the class program naturally becomes the varsity program.

A large number of schools have neither locker rooms nor showers, and most of the total group state that such facilities are inadequate. Lack of these facilities is most commonly found in the smaller schools, while inadequacy of facilities occurs in the larger schools. Differences in curricular offerings, as well as differences in enrollment, may be the explanation.

Tables III and IV re-emphasize certain accepted facts. Salaries are smaller for women than for men, although this discrepancy is not so apparent in the larger schools. Salaries increase progressively with pupil enrollment in normal times. Most teachers are still hired on a nine-month basis, although some are being hired for ten or even twelve months. Fifty women and sixty-one men in this study had such arrangements. While this may actually mean receiving a ten-months' salary in twelve equal installments, there is an increasing trend to hire teachers, especially men, on a twelve-month basis, to carry on community recreation during the summer months.

Although twenty-four men and eighteen women who responded did not have a bachelor's degree, one hundred fifty-five men and seventy-seven women had already received a master's degree, and thirty-six men and twenty-eight women were doing work beyond this level. This indicates interest in professional growth, but is of minor significance, since it includes only a small percentage of the total group. Furthermore, as will be shown later, much of the training beyond the bachelor's degree is in areas other than physical education.

The largest number of men and women who responded, had physical education as their field of major specialization, but an analysis of the data shows this represents only 34 per cent of the men and 27 per cent of the women. The conclusions are obvious. Many of our teachers of physical education are not as well prepared in that field as in certain academic areas. This may be due to lack of emphasis placed on physical education as an important subject in many systems, or it may be the result of the heavy requirements which must be met by most teachers, in the academic subjects in several fields. The inference seems to be that the stress in teacher training should be on a good minor in physical education, and one or

two majors in "live" academic subjects, to meet the existing situation in most schools. (See Tables V and VI.)

In Tables VII and VIII, practically all individuals represented had two or three minors. No distinction is made between a first, second, or third minor. The majority of such minors represent sixteen to twenty hours in a certain area, and in certain combinations.

Physical education was most frequently mentioned but this represents only 22 per cent of the men who replied to this question. The minors for women were, in order, English (27 per cent), science (13 per cent), history (11 per cent), and physical education, fourth, with 42 teachers, or 9 per cent of the group listing it. When we recall that only 34 per cent of the men and 27 per cent of the women had majors in physical education, and then re-evaluate the two tables just preceding, we find that approximately half of the group had either a major or a minor in this field. Once again, the conclusion mentioned earlier is re-affirmed; the majority of the teachers of physical education in the state of Illinois who responded to this study are either inadequately prepared (as judged by college preparation in the area) or not prepared at all, for this part of the school program!

Tables IX, X, represent 68 per cent of the men and 54 per cent of the women who responded to this question. Education is the most frequent area of specialization, listed by 38 per cent of the men, and 27 per cent of the women. Physical education, with totals of 33 per cent and 26 per cent, respectively, is second. Most of the advanced preparation was either in general fields (i. e., education) or specific academic areas. Many of this group appear to have had inadequate undergraduate preparation in physical education.

The picture deviates slightly from that in the undergraduate minor, and the graduate major preparation. Education is once again mentioned most frequently by the men (24 per cent) with physical education second. This subject, however, is mentioned most frequently by the women (15 per cent) with English close behind.

The data on teaching load, and weekly schedule of activities has not been completely summarized. Besides it does not lend itself readily to presentation in table form, so it will be omitted. However, in another survey by the writer[3] to which 72 per cent of the accredited schools responded, it was found that "almost half of those listed as instructors of physical education devote five hours or less per week to instruction in this field, while the great bulk of their teaching is in one or more of the academic fields. About one-

[3] C. O. Jackson, "The Status of Physical Education in the Accredited Secondary Schools of Illinois," *Research Quarterly*, 9:1 (March, 1938) 55.

third spend from six to ten hours weekly teaching physical education, and less than fifty spend as much as fifteen hours teaching in this field . . . Sixty-nine instructors, the majority in the larger schools, devote full time to teaching physical education and coaching sports . . . "

The situation has probably not changed materially since that time. When we consider the fact, also, that almost all teachers in physical education have coaching or other extracurricular activities, it is evident that the teaching load is probably heavier than in any other subject area. This is even more true today, with an ever-increasing shortage of coaches and teachers of physical education, due to the war.

Almost half of the men teachers (46 per cent) indicated that summer school was their occupation in 1939, while 38 per cent of the women teachers also attended school. It seems logical to assume that the desire to become better prepared professionally was the most important motivating factor, but the prospect of greater financial remuneration undoubtedly enters in as well. The surprising thing is that so few men go to summer school, earning advanced credits and advanced degrees. Most of them have families and need better salaries. Perhaps one reason why less than half go to summer school is that the cost of education, especially during the summer, is still high. Furthermore, many positions at high pay are frequently open to both men and women teachers during the summer, which may also interfere.

The data showing professional affiliation is obsolete, since the situation has been improved considerably since this study was made. An earlier survey[4] indicated that "only 15 per cent of the teachers (representing 72 per cent of those in the accredited secondary schools in Illinois) were members of state or national organizations in physical education . . ." In 1940, due to a concerted drive on the part of the officers of the Illinois Physical Education Association, there was an increase in membership of between 300 and 350 per cent. The total membership in this association and the American Association for Health, Physical Education, and Recreation has receded somewhat since then, but it is still much higher than the data in this study indicates. (See Tables XIII and XIV.)

Most of the group are members of the Illinois Education Association or the National Education Association, or both, probably because administrators in many systems encourage such affiliations. Many are also members of various state and national groups interested in certain academic subject-matter areas.

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4 C. O. Jackson, *The Status of Physical Education in the Accredited Secondary Schools of Illinois*, p. 56.

TABLE XV

SELF-EVALUATION OF DEFICIENCIES IN TRAINING
(Information received from 414 men and 350 women)

MEN	WOMEN
1. Safety (94)	1. Training inadequate (55)
2. Health (63)	2. Physical education (41)
3. Physical education (50)	3. Health (32)
4. Recreation (42)	4. Safety (29)
5. Training inadequate (23)	5. Recreation (20)
6. Coaching (19)	6. Coaching (5)

Items listed less than five times are not included in the above totals.

The greatest number of deficiencies mentioned are in areas which in 1939 were comparatively new, as far as emphasis in the secondary schools is concerned. In many cases, the person who responded stated that his or her training was "adequate." This was true of 150 men (26 per cent) and 122 women (25 per cent). As might be expected, a number failed to answer this question.

There were numerous instances where the person responding qualified the answer by adding "adequate for the present situation." A check on the enrollment almost always revealed a small school situation. Perhaps in some cases, the person was too subjective in evaluating his preparation, and in other instances, the criteria used may have been too high, or too low. It is interesting that very few individuals considered their coaching preparation inadequate, as compared to those who felt they needed additional training in other areas of physical education.

SUMMARY

The following statements summarize the conclusions reached from the study, and include those presented or implied in the earlier article[5] as well.

1. Most high schools require two forty-minute periods of physical education a week every semester, for credit.

2. Health and safety education, if taught, are probably included in the physical education curriculum.

3. The principals in almost all of the high schools feel that the facilities and equipment for physical education are adequate.

4. The average salaries are low, with those paid men higher than those received by women. The size of the school is an important factor in determining the remuneration.

5. Almost all instructors in this survey have a bachelor's degree, with a large number working toward a master's degree, or already in possession of one. A break-down of tabulation indicates that both groups list "physical education" as the most frequent major, but this represents less than a fourth of the total responding. The bal-

[5] C. O. Jackson, "Activities Engaged in by Teachers of Physical Education in the High Schools of Illinois."

ance of the majors fall under twenty-six different headings for the men, and forty for the women. It appears that the teachers of physical education are well trained in a variety of academic subjects.

6. The teacher of physical education must be a "jack of all trades" and master of many.

7. Giving first aid to students is the most important single task for both groups, although "keeping the team in condition" is a close second for the men.

8. The promotion of intramurals appears to be important, but the variety and range of activity leaves much to be desired.

9. Relatively few instructors indicated they were carrying on a testing program. Achievement tests and tests of knowledge were checked more frequently than other items.

10. Purchasing equipment and supplies is the most frequent single duty in the financial sphere for both men and women.

11. Church work, and speeches, rank first and second under "miscellaneous duties."

12. More women instructors travelled, and more men went to summer school during 1939, than engaged in any other activity.

13. The largest number of men and women who were affiliated with professional organizations belong either to the Illinois Education Association, or the National Education Association, or both.

14. A great variety of activities is included in the curriculum, but a few of the so-called "varsity sports" appear to predominate, and in many instances, probably constitute the program, both in class, and in intramurals.

15. Many instructors indicated their training was "adequate" but often qualified this by adding "for the present situation." The great majority who listed deficiencies, mentioned "safety," "health," and "physical education" as areas where they need training.

CONCLUDING STATEMENT

Many of the classes in physical education, and most, if not all of the coaching is carried on by individuals who also teach a heavy load of academic subjects. Under such circumstances, it is natural to find strong majors in academic subjects, and the minimum, or less, in physical education.

Until the administrators of our secondary schools change the traditional emphasis, and place less stress on academic learning, and as much, or more, on the acquisition of motor skills and physical fitness for all, few permanent changes will result, in spite of the existing national emergency. The problem is further complicated by the fact that many competent men and women who have been teaching physical education are now in branches of the service, while

others have defense positions where their talents command much greater remuneration than formerly.

Perhaps the goal from now on, in our profession, should be "selling" the standards which make possible a real curriculum, to superintendents, principals, and school board members. After all, they determine the limits within which we may operate, by deciding on time allotment, number of periods, size of classes, the adequacy of facilities and equipment, and the training and experience of teachers. It is apparent that few school systems have made the greatest possible use of the talents of the staff, and the existing facilities. A complete survey of the needs of each individual community and school, with a study of the existing situation, probably would furnish a starting point.

The data secured in this study was helpful in clarifying the existing situation in physical education in the secondary schools of Illinois. When considered along with information received since the study was made, and in light of the existing national emergency, certain gaps and weaknesses are indicated in teacher-training curricula. However, the whole-hearted cooperation and understanding of school administrators, board members, teachers of physical education, and leaders in teacher-training institutions is necessary to improve the status of physical education in the schools.

NOTE: The study which made possible the collecting and dissemination of this data was financed by the College of Education and the School of Physical Education. A committee of six, including Dr. E. F. Potthoff and Dr. C. W. Sanford of the College of Education; Miss Louise Freer and Dr. S. C. Staley of the School of Physical Education; and Miss Florence Lawson and the writer who divide time between the College of Education and the School of Physical Education, developed the inquiry blanks and helped determine the direction of the survey.

Special credit is given to J. E. Lotzer, University of Illinois student, and N.Y.A. assistant, who sent out the inquiry blanks, and through painstaking and conscientious work, completed the initial tabulation of the data.

TABLE I

ORGANIZATION

(Information supplied by 440 principals)

GROUP		A		B		C		D		E		F		G	
Total Schools Represented		60		90		149		65		30		24		18	
Per cent of return		25%		39%		53%		70%		61%		72%		36%	
Enrollment:															
Boys		845*		3,160		3,152*		9,499*		7,523*		13,883		36,023	
Girls		860*		2,116		3,296*		10,601*		7,218*		15,890		30,264	
Total		1,849		5,276		7,434		22,022		20,264		29,773		66,287	
Type of School															
Sr. High 2 yr.		5		0		0		0		0		0		0	
Sr. High 3 yr.		34		5		1		2		1		5		1	
Sr. High 4 yr.		21		85		146		63		29		19		17	
No. Physical Ed. Teachers		B. 39	G. 35	B. 88	G. 86	B. 163	G. 162	B. 70	G. 63	B. 41	G. 32	B. 44	G. 40	B. 80	G. 62
Semesters P. Ed.		B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.
Required	8	15	16	67	66	97	98	26	30	9	8	9	10	13	13
	6	14	14	3	3	2	3	5	4	3	3	1	1	2	2
	4	7	7	7	7	29	28	23	22	14	14	8	9	1	1
	2	0	0	4	5	4	4	3	2	1	1	4	3	1	1
	None	22	22	3	4	13	12	1	2	2	3	0	1	0	0
Class Meetings per Week:		B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.
Daily		3	2	2	1	5	2	1	1	2	1	1	1	0	0
Four		4	2	1	1	1	2	2	1	1	1	0	0	0	0
Three		4	1	3	1	5	1	5	6	2	3	7	7	8	9
Two		21	27	60	59	101	108	47	49	18	18	15	15	7	7
One		7	8	17	20	22	25	3	4	5	4	1	2	0	0
Length of Period		B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.
60 minutes		9	5	12	10	21	20	9	10	7	6	4	5	1	1
55 "		1	1	2	2	5	5	5	5	2	2	1	1	1	1
50 "		0	0	3	3	6	5	6	6	5	5	1	1	0	0
45 "		6	7	20	22	25	24	11	11	4	6	1	1	0	0
40 "		15	16	31	31	43	48	13	14	4	3	6	8	10	8
35 "		3	3	3	3	16	16	3	5	5	5	0	0	0	0
30 "		3	4	13	15	16	15	12	11	0	0	3	2	4	4
25 "		0	0	0	0	1	1	0	0	0	0	1	1	1	2
20 "		2	2	0	0	0	0	0	0	0	0	0	0	0	0
Health and Safety Instruction included in P. Ed.		Yes 22	No 38	Yes 50	No 40	Yes 79	No 70	Yes 48	No 17	Yes 22	No 8	Yes 20	No 4	Yes 16	No 2

*Not all schools responding listed specific enrollment for boys and girls.

Health and Safety Instruction included in P. Ed.	Yes 22	No 38	Yes 50	No 40	Yes 79	No 70	48	17	22	8	20	4	16	2

*Not all schools responding listed specific enrollment for boys and girls.

TABLE II

FACILITIES

(Information supplied by 440 principals)

GROUP	A		B		C		D		E		F		G	
Total Schools Represented	60		90		149		65		30		24		18	
Gymnasium	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	31	28	86	4	144	5	6	1	30	0	24	0	17	1
Large (60 x 90)	4		7		41		31		21		21		17	
Medium (40 x 60)	17		66		97		33		9		5		10	
Small (less)	9		13		10		1		1		0		1	
Play Room	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	14	45	16	74	40	99	10	53	4	26	6	18	6	12
Large (40 x 60)	4		2		11		3		3		2		3	
Medium (20 x 30)	3		11		22		5		0		0		4	
Small (less)	6		3		4		2		1		2		0	
Athletic Field	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	40	18	76	14	135	13	60	5	28	2	22	1	9	9
Large (10 Acres or more)	2		4		17		11		10		10		4	
Medium (6-9A.)	11		30		62		30		11		6		4	
Small (less)	24		35		52		18		7		4		1	
This Field is Used for:														
Baseball	29		57		93		38		13		14		8	
Football	3		14		73		52		28		20		9	
Track	14		39		96		51		23		20		9	
Soccer	3		16		52		34		19		12		6	
Softball	39		64		111		47		17		18		8	
Hockey			4		16		15		9		10		5	
Others	5		4		9		4		2					

Playground	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	55	5	59	31	84	65	40	25	18	12	17	7	7	11
Large (7A. or over)	3		1		10		7		1		3		2	
Medium (3-6A.)	3		22		16		14		4		8		2	
Small (2A. or less)	44		28		54		19		11		4		3	
Surfacing:														
Sod	42		49		63		26		13		10		2	
Clay	7		5		8		6		4		3		0	
Gravel	1		3		3		4		0		1		2	
Cinders	3		2		6		1		0		1		2	
Others	0		0		0		0		0		0		1	
Tennis Courts	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	21	39	30	60	47	82	35	29	19	11	11	13	5	13
Number	23		35		150		76		48		62		33	
Surfacing:														
Sod	7		2		4		0		0		0		0	
Clay	13		29		51		48		11		29		0	
Asphalt			0		4		17		1		25		2	
Concrete	1		4		5		12		5		10		3	
Swimming Pool	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	0	60	1	89	7	142	5	60	7	23	11	13	15	3
Large (30 x 75)	0		1		2		4		3		5		7	
Medium (20 x 60)	0				5		1		4		6		9	
Small (less)	0		0		0		0		0		0		0	
Locker Rooms	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Sufficient?	18	41	59	31	102	47	47	18	21	9	22	2	17	1
Showers	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Sufficient?	20	39	69	21	114	35	52	13	24	6	23	1	17	1
Adequate	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Facilities?	23	35	59	31	98	51	43	22	20	10	18	6	8	10
Adequate	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Equipment?	37	21	72	18	113	36	59	6	29	1	23	1	18	0

TABLE III

PERSONAL DATA

(Information supplied by 538 men teachers)

GROUP	A		B		C		D		E		F		G		Totals		Rank
Number	38		88		152		78		46		49		87		538		*
Salary (Av.)	$1368		$1460		$1524		$1824		$1965		$2633		$2658		$1918		*
9 months	34		73		127		38		19		16		32		339		1
10 months	1		3		7		19		14		27		44		115		2
12 months	3		10		16		15		7		5		5		61		3
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
B. S. Degree	33	3	76	1	146	5	73	2	45	1	45	4	78	8	496	24	1
Beyond	19	17	55	33	100	49	58	20	39	6	34	14	61	26	366	166	2
M. S. Degree	8	30	17	71	34	104	32	43	22	23	13	36	29	62	155	369	3
Beyond	2	36	5	83	8	140	6	71	6	29	2	46	7	84	36	489	4

TABLE IV

PERSONAL DATA

(Information supplied by 467 women teachers)

GROUPS	A		B		C		D		E		F		G		Totals		Rank
Number	29		79		141		67		35		44		72		467		*
Salary (Av.)	$1018		$1182		$1215		$1400		$1887		$1900		$2589		$1594		*
9 months	26		64		107		36		14		13		22		282		1
10 months	1		12		16		16		12		27		28		112		2
12 months	2		2		12		15		8		3		8		50		3
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
B. S. Degree	24	3	71	0	134	5	65	3	34	0	43	1	66	6	437	18	1
Beyond	10	19	29	40	70	58	40	23	27	8	32	12	37	14	254	174	2
M. S. Degree	1	24	7	72	20	118	8	58	9	24	10	33	22	47	77	376	3
Beyond	0	26	4	74	5	128	2	64	3	30	4	39	10	58	28	419	4

TABLE V

UNDERGRADUATE MAJORS IN COLLEGE

(Information supplied by 517 men)

GROUP	A	B	C	D	E	F	G	Total	Rank
Number in Group	34	88	159	74	41	57	90	517	
Subject									
Physical Education	2	26	25	28	18	34	46	179	1
History	2	12	20	6	4	4	4	52	2
Social Science	7	7	19	8	4	2	2	49	3
Mathematics	6	7	23	5	0	2	3	46	4
Education	3	0	7	5	3	2	18	38	5
Biology	1	5	10	5	1	1	3	26	6
Industrial Arts	2	5	10	4	1	3	0	25	7
Science	4	1	10	2	2	3		22	8
Chemistry	1	8	7	1	2	0	1	20	9
Commercial	0	5	7	1	1	1	1	16	10
Economics	0	1	1	3	3	1	2	11	11
Physics	2	0	8	1	0	0	0	11	11
Agriculture	1	5	1	0	0	1	0	8	12
Political Science	1	1	0	1	0	1	1	5	13
English	1	0	0	1	1	0	2	5	13

NOTE: Business administration, geography, zoology, coaching, psychology, speech, agricultural education, art, French, geology, language, and Spanish follow in that order, but too few times to be listed in the table.

TABLE VI

UNDERGRADUATE MAJORS IN COLLEGE

(Information supplied by 445 women)

GROUP	A	B	C	D	E	F	G	Total	Rank
Number in Group	26	66	152	61	30	38	72	445	
Subject									
Physical Education	0	1	10	31	16	26	45	129	1
Home Economics	3	22	33	3	1	0	1	63	2
English	9	12	20	5	4	0	6	56	3
Mathematics	1	6	10	4	3	2	0	26	4
History	2	2	14	4	0	0	1	23	5
Commercial	0	9	11	3	0	0	0	23	5
Education	0	3	3	2	2	1	8	19	6
Latin	2	4	11	0	1	0	0	18	7
Biology	1	1	6	1	0	1	1	11	8
Social Science	0	0	4	0	1	4	1	10	9
Music	2	2	5	0	0	0	0	9	10
French	0	1	5	1	1	0	1	9	10
Business Administration	0	1	2	2	0	1	0	6	11
Science	0	0	5	0	0	0	1	6	11
Economics	0	0	3	1	0	0	1	5	12

NOTE: Psychology, speech, botany, zoology, art, language, sociology, chemistry, geography, physics, classics, accountancy, health, general science, journalism, hygiene, German, anatomy, and physical science follow in that order, but too few times to be listed in the table.

TABLE VII

MINORS ON UNDERGRADUATE LEVEL
(Information received from 569 men)

GROUP	A	B	C	D	E	F	G	Totals	Rank
Number in Group	52	96	159	74	41	57	90	569	
Subject									
Physical Education	9	25	40	24	11	11	8	128	1
Mathematics	8	19	22	13	2	5	9	78	2
English	7	12	24	4	4	3	17	71	3
Science	3	10	12	9	9	9	13	65	4
History	4	5	22	9	8	6	9	63	5
Social Science	4	19	12	6	4	1	5	51	6
Biology	2	14	7	13	2	1	5	44	7
Education	2	8	12	0	4	6	7	39	8
Industrial Arts	0	6	2	9	4	2	2	25	9
Physics	2	7	7	3	3	2	0	24	10
General Science	0	1	0	0	0	0	15	16	11
Chemistry	1	3	2	5	0	0	2	13	12
Physiology	0	2	1	3	1	0	6	13	12
Sociology	0	0	0	2	2	3	5	12	13
Political Science	2	2	5	0	1	1	0	11	14
Economics	0	1	3	0	1	4	1	10	15
Geography	1	2	3	0	1	1	1	9	16
German	2	2	2	0	0	0	2	8	17
Botany	0	1	3	3	0	0	0	7	18
Latin	1	2	2	0	0	0	0	5	19
Psychology	0	2	1	0	1	0	1	5	19
Commercial	0	1	2	0	0	1	1	5	19

NOTE: Agriculture, philosophy, Spanish, speech, hygiene, language, health, related subjects, French, coaching, music, finance, administration, geology, pre. med., journalism, swimming, fencing, and zoology follow in that order, but too few times to be listed in the table.

TABLE VIII

MINORS ON UNDERGRADUATE LEVEL
(Information received from 445 women)

GROUP	A	B	C	D	E	F	G	Totals	Rank
Number in Group	26	66	52	61	30	38	72	445	
Subject									
English	10	26	22	21	8	15	18	120	1
Science	4	11	9	9	4	11	9	57	2
History	7	9	11	8	2	3	10	50	3
Physical Education	0	4	11	12	5	7	3	42	4
Education	1	7	9	5	5	3	11	41	5
Social Science	4	8	8	5	2	4	6	37	6
French	4	5	9	3	5	2	2	30	7
Biology	3	4	5	7	3	3	2	27	8
General Science	0	10	0	2	0	0	15	27	8
Latin	2	7	10	3	0	0	0	22	9
Chemistry	1	5	8	2	3	0	0	19	10
German	2	2	2	1	0	1	3	11	11
Mathematics	1	0	3	2	4	1	0	11	11
Home Economics	0	4	2	4	0	1	0	11	11
Physics	0	3	5	1	1	0	0	10	12
Speech	0	1	1	4	1	2	0	9	13
Psychology	0	0	1	1	0	1	6	9	13
Commercial	0	5	1	2	0	0	0	8	14
Sociology	1	0	1	0	1	0	3	6	15
Zoology	0	0	1	0	2	3	0	6	15

NOTE: Spanish, music, political science, economics, accountancy, physiology, hygiene, health, art, language, drama, commerce, geography, gym, journalism, government, fine arts, dancing, guidance, social work, secretarial, business administration, philosophy, and geology follow in that order, but too few times to be listed in the table.

TABLE IX

GRADUATE MAJORS IN COLLEGE
(Information received from 274 men)

Group	A	B	C	D	E	F	G	Total	Rank
Number in Group	19	38	53	53	38	24	49	274	
Subject									
Education	13	22	14	22	11	9	27	105	1
Physical Education	1	4	19	21	24	13	9	91	2
History	0	1	4	1	0	2	0	8	3
Zoology	0	1	0	2	0	0	3	6	4
Chemistry	1	2	2	0	0	0	0	5	5
Administration	0	2	0	1	0	1	1	5	5
Industrial Arts	0	1	2	1	0	0	1	5	5
Science	0	0	1	2	0	0	1	4	6
Social Studies	1	0	1	1	0	0	1	4	6
Health	0	0	0	0	0	1	2	3	7
Physics	1	0	1	0	1	0	0	3	7
Commercial	0	1	1	0	0	0	0	2	8
Psychology	0	0	0	0	0	1	1	2	8
Guidance	0	1	0	0	0	0	1	2	8

NOTE: Educational administration, medicine, entomology, accountancy, bacteriology, Latin, mathematics, political science, economics, and botany follow in that order, but too few times to be listed in the table.

TABLE X

GRADUATE MAJORS IN COLLEGE
(Information received from 202 women)

Group	A	B	C	D	E	F	G	Total	Rank
Number in Group	4	20	61	28	20	23	46	202	
Subject									
Education	0	4	10	7	7	6	22	56	1
Physical Education	1	4	19	21	24	13	9	54	2
History	1	4	3	0	0	1	1	10	3
English	0	2	5	2	0	0	0	9	4
Commercial	0	2	6	0	0	0	0	8	5
Home Economics	1	5	1	0	0	0	0	7	6
Latin	0	0	4	1	0	0	0	5	7
Biology	1	0	2	2	0	0	0	5	7
Mathematics	0	0	4	1	0	0	0	5	7
French	0	1	4	0	0	0	0	5	7
Zoology	0	0	3	1	0	0	0	4	8
Social Studies	0	0	2	1	0	0	0	3	8
Science	0	0	0	1	0	1	1	3	8
Botany	1	0	0	1	1	0	0	3	8
Speech	0	0	1	2	0	0	0	3	8
Guidance	1	0	0	0	0	1	0	2	9
Business Administration	0	0	0	2	0	0	0	2	9
Health	0	0	0	0	1	0	1	2	9
Psychology	0	0	1	0	0	0	1	2	9

NOTE: Administration, German, hygiene, dance, physical therapy, economics, music, English literature, school administration, classics, business education, L.A.S., administration, geography, and chemistry follow in that order, but too few times to be listed in the table.

TABLE XI

GRADUATE MINORS IN COLLEGE
(Information received from 219 men)

Group	A	B	C	D	E	F	G	Total	Rank
Number in Group	14	38	53	28	38	24	24	219	
Subject									
Education	6	2	14	5	7	9	8	51	1
Physical Education	1	6	15	13	4	7	2	48	2
History	2	5	13	0	0	3	2	25	3
Social Science	0	0	19	0	0	0	2	21	4
English	0	0	12	0	0	0	2	14	5
Science	0	1	3	0	0	1	4	9	6
Mathematics	0	2	7	0	0	0	0	9	6
Administration	0	1	1	2	0	1	3	8	7
Hygiene	0	0	2	1	2	2	1	8	7
Health	0	1	3	2	0	1	0	7	8
Sociology	1	1	0	0	0	1	3	6	9
Physics	1	0	4	0	0	0	1	6	9
Biology	0	2	4	0	0	0	0	6	9
Psychology	0	1	0	2	1	0	2	6	9
Industrial Arts	0	0	4	1	1	0	0	6	9
Physiology	0	0	3	0	0	1	0	4	10
Economics	0	0	3	1	0	0	0	4	10
Political Science	0	0	2	0	2	0	0	4	10
Chemistry	0	3	0	0	0	0	0	3	11
Spanish	0	0	3	0	0	0	0	3	11
Geology	0	0	3	0	0	0	0	3	11

NOTE: Zoology, economics, guidance, French, German, biological science, general science, commercial, coaching, physical science, geography, recreation, commerce, law, bacteriology, chemistry, agriculture, language, journalism, welfare, testing, philosophy, botany, and speech follow in that order, but too few times to be listed in the table.

TABLE XII

GRADUATE MINORS IN COLLEGE

(Information received from 202 women)

Group	A	B	C	D	E	F	G	Total	Rank
Number in Group	4	20	61	28	20	23	46	202	
Subject									
Physical Education	0	1	17	5	2	2	5	32	1
English	0	5	19	1	1	1	2	29	2
Education	1	1	10	2	3	4	7	28	3
History	0	1	10	1	0	1	4	17	4
Social Science	0	1	6	0	0	1	1	9	5
Biology	0	2	3	0	0	2	0	7	6
French	0	1	6	0	0	0	0	7	6
Latin	0	1	5	0	0	0	0	6	7
Science	0	0	5	0	0	0	1	6	7
Guidance	0	0	1	1	1	1	2	6	7
Psychology	0	0	0	0	1	1	3	5	8
Commercial	0	2	1	1	0	0	0	4	9
Zoology	1	0	1	1	0	1	0	4	9
Chemistry	0	0	4	0	0	0	0	4	9
Mathematics	0	0	2	0	1	1	0	4	9
Speech	0	0	2	0	0	2	0	4	9
Sociology	1	0	0	0	2	0	0	3	10
German	0	0	2	0	1	0	0	3	10
Health	0	0	0	1	0	2	0	3	10
Political Science	0	2	0	0	0	0	0	2	11
Art	0	1	1	0	0	0	0	2	11
Music	0	0	2	0	0	0	0	2	11
Economics	0	0	2	0	0	0	0	2	11
Physiology	0	0	1	0	0	1	0	2	11
Hygiene	0	0	0	0	0	0	2	2	11
Orthopedics	0	0	0	0	0	0	2	2	11

NOTE: Geography, home economics, general science, administration, testing, piano, library, government, Spanish, dramatics, physics, and pedagogy follow in that order, but too few times to be listed in the table.

TABLE XIII

SUMMER OCCUPATION—PROFESSIONAL INTERESTS

(Information received from 538 men)

Group	A	B	C	D	E	F	G	Total	Rank
				Summer Occupation (1939)					
Summer School	20	52	88	28	19	19	25	251	1
Travel	11	32	40	20	14	12	33	162	2
Rest	4	21	38	18	6	10	33	130	3
Other Remunerative Work	10	21	34	12	16	8	8	109	4
Camp Work	2	9	5	7	6	9	15	53	5
Playground	0	4	13	8	5	6	2	38	6
Life guard	3	2	3	6	1	5	7	27	7
				Membership in Professional Organizations					
Illinois Educ. Assoc.	33	65	111	53	32	28	54	376	1
Illinois Coaches' Assoc.	14	33	73	45	25	34	15	239	2
N.E.A.	14	18	39	29	16	26	33	175	3
Miscellanenus (social science, biology, mathematics, organization, etc.)	3	10	120	12	4	6	31	166	4
Illinois Phys. Educ. Assoc.	5	14	25	23	17	23	29	136	5
A.A.H.P.E.R.	1	3	12	16	11	9	50	102	6
Phi Delta Kappa	4	7	8	7	9	4	4	41	7
Kappa Delta Pi	4	7	12	3	4	1	0	31	8

TABLE XIV

SUMMER OCCUPATION—PROFESSIONAL INTERESTS

(Information received from 467 women)

Summer Occupation (1939)

Group	A	B	C	D	E	F	G	Total	Rank
Travel	12	36	53	30	12	25	46	214	1
Rest	11	37	58	26	7	20	42	201	2
Summer School	12	27	56	28	20	19	15	177	3
Camp Work	0	4	13	9	10	8	7	51	4
Other Remunerative Work	4	7	12	6	1	1	6	37	5
Life guard	0	1	6	3	3	3	2	18	6
Playground	0	1	5	3	2	2	2	15	7
Membership in Professional Organizations									
Illinois Educ. Assoc.	25	55	101	51	23	34	51	340	1
N.E.A.	2	13	32	26	16	27	38	154	2
A.A.H.P.E.R.	0	1	11	19	19	32	44	126	3
Illinois State Phys. Ed.	1	3	14	11	15	18	19	84	4
Miscellaneous	3	0	7	4	0	4	16	34	5
Kappa Delta Pi	2	8	7	3	0	1	5	26	6
Illinois Coaches' Assoc.	1	1	3	3	1	2	4	15	7

A System of Evaluating Teachers in Physical Education

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BEFORE considering the process of constructing a rating scale for physical education teachers it would be expedient from the standpoint of clarification to present a background of information relative to the history, purpose, use, and need of rating devices.

HISTORICAL DEVELOPMENT OF RATING SCALES

Rating methods of one kind or another can be traced back to the early life of the Greeks, but the scientific effort had its beginnings in the work of Fechner and Mantegazza in the field of psychophysics.[1]

Sir Francis Galton, however, is accredited with having published, in 1883, the first rating scale in a modern sense.[2] It is still considered today an outstanding scale of its kind.

The famous scale is in the field of sensitivity. Standard descriptions of qualities are arranged in linear order. Each subject marks his own degree of sensation on the scale, or checks that term which seems most similar to his own experiences. This marking is done in a manner in which the judgment of one person can be compared with that of another.

Educational rating scales came into being in 1910 when Elliott[3] constructed a scale from 100 traits to which he assigned weights. The scale, however, when put in use proved of very little value. None of the correlations made exceeded 0.2 and many were negative.

A little later Boyce[4] set up a rating scheme consisting of 45 qualities which were described briefly and rated in 10 divisions.

Miner[5] in 1916 made a very important contribution to the cause of rating scales when he constructed a scale from 5 character traits

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1 Percival M. Symonds, *Diagnosing Personality and Conduct.* (New York: The Century Co., 1931) 52.

2 Sir Francis Galton, *Inquiry into Human Faculty and Its Development.* (New York: E. P. Dutton and Co., Inc.) 54-65.

3 Harold Rugg, "Is Rating of Human Character Practicable?" *Journal of Educational Psychology,* XII (November, 1921) 426.

4 *Ibid.,* p. 427.

5 J. B. Miner, "The Evaluation of a Method for Finely Graduated Estimates of Abilities," *Journal of Applied Psychology,* (1917), 123.

and patterned it after Galton's, in that the subjects were rated as to what fifth of the scale in which they would be classified.

Another scale, which came in about this same time and which seems to be the most promising one for both education and industry was Scott's Man-to-Man Rating Scale. Scott constructed this scale as an experiment in class work while at Carnegie Institute of Technology and it was applied to employees in industry. The scale was by far the best that had ever been set up before because ratings could now be made objectively, something which previous scales had failed to do.

Rating was done by first selecting key or scale men. These were placed in a vertical line with sufficient space between for other names. First, "the best man you ever knew" was selected, and his name placed at the top of the list. Second, "the poorest man you ever knew" was chosen and his name placed at the bottom of the list. Then an "average man" was selected and his name placed half way between these two other men's names. Similarly a "better-than-average man" and a "poorer-than-average man" were chosen and placed in their respective positions. Each of these five men was given a number as 15, 12, 9, 6, and 3. All one needed to do to rate an individual was to compare him with each of these five men to see whether he rated worse or better in one particular quality and place him in the proper relation with them.

With the entry of the United States in the World War in 1917, Scott, along with Bingham, Strong, Cass, and others, were placed on a committee on Classification of Personnel to measure human abilities. The result was the construction of the Army Rating Scale for rating of officers' efficiency.

After the World War the man-to-man rating scale was put into use by industry but with little success, owing to the fact that qualities of character which were deemed essential to test could be measured only after considerable expenditure of time and money. There was no certainty, either, of the validity of the tests. Business and education people found the same difficulty with this type of scale. Generally speaking the man-to-man rating scale was considered too cumbersome, invalid, and expensive to be used to any extent in these fields.

During 1921-22 Rugg[6] published several articles criticizing rating scales up to that time and pointing out the many weaknesses. His articles had so much influence that rating scales became unpopular and were used very little for the next few years. Rugg criticized the man-to-man scale and others on the score that the rating of character is influenced by the subject's personality or

[6] H. O. Rugg, "Is Rating of Character Possible?" *Journal Educational Psychology*, XIII (1921), XIII (1922).

personal qualities; that the meaning of traits is accomplished by the means of a single judgment; and that the measuring of traits of character is not done objectively.

About 1923 the Scott Company of Philadelphia constructed a graphic scale for use in industrial personnel work. This was the first important scale following the decline in popularity of scales after Rugg's famous articles criticizing their use. Experimenters, educators, and psychologists admitting, no doubt, that scales were not testing what they were supposed to test and in many respects faulty, they were not yet convinced of the absolute worthlessness of them; they still felt that there was some value in scales, that there was some good to be salvaged. The need now was to gather up what good remnants there were and to remold and remodify them into real, tangible, objective, and useful scales.

Scott's Graphic scale includes seven qualities, each quality being divided into four divisions according to descriptive terms. A sample follows:

SCOTT'S GRAPHIC SCALE[7]

Ability to Learn:					
Consider the ease with which this employee is able to learn new methods and to follow directions given him.	Very Superior	Learns with ease	Ordinary	Slow to Learn	Dull

The advent of Scott's Graphic rating scale stirred up anew the interest in scales. This time such educational psychologists as Symonds, Hallingworth, Allport, and Thurston commenced to pay particular attention to what was being done along this line and began to make systematic analysis and to suggest methods of studying scales. Some of the things they considered important were instructions to and qualifications of raters, the desirability of rating conduct rather than trying to determine to what degree a person possesses a certain trait.

Conduct Scales came into use about 1929 as a result of the emphasis on Conduct Habits. The sample below reveals the judgment of the fact type used:

Cooperation:[8]

A. Works well with others if asked to do so.
B. Works better alone. Cannot get along with others.
C. Works well and gladly with others.
D. Indifferent as to whether or not he works with others.
E. Usually antagonistic or obstructive to joint effort.

A Graphic Scale devised by a committee of the American Council on Education in 1928 was constructed for use in Colleges and Universities for rating personalities of students.

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7 D. G. Paterson, "Methods of Rating Human Qualities," *Annuals of the American Academy of Political Science*, CX (1923), 81-93.

8 Mary A. May, and Hugh Hartshorne, "Recent Improvements in Devices for Rating Character," *Journal of Social Psychology*, I (Feb. 1930), 66-77.

The following is a sample of the "Personality Rating Scale":

PERSONALITY REPORT[9]

Name of Student.....

How are you and others affected by his appearance and manner?	Avoided by others	Tolerated by others	Liked by others	Well Liked by others	Sought by others	No opportunity to observe

.....

Please record here instances that support your judgment.

The scale was constructed around the following five qualities: personal charm, initiative, leadership, emotional control, and responsibility, and has five degrees on which to rate the question under consideration.

With the advent of the American Council Scale and the popularity it enjoyed rating scales in general began to take on new life.

The Check List was another type of scale originally devised by Hepner[10] but later developed by Hartshorne and May[11] very successfully.

The Check List consisted of two lists of eighty words each. One list contained words which were descriptive of approval and the other of disapproval. For each word that appeared in one list its antonym appeared in the other. Positive and negative words appear on both lists. A teacher rates a student by checking those words which apply to the student. The score is determined by subtracting the total number of negative words from the total number of positive words. The final score might be either positive, zero, or minus. The reliability of this technique for total reputation is .88.

The Self-Ordinary-Ideal Rating Scale is another rating scheme worth mentioning here. Its basis of construction is on the tendency for a person to overrate himself on desirable qualities. It was originally formulated by Knight and Frazen, later experimented with by G. B. Watson and finally developed by Sweet.[12]

Many other scales which have been constructed in the last few years could be mentioned, but space does not permit them to be included in this article.

THE PURPOSE OF RATING SCALES

The original purpose of rating scales was primarily diagnostic and that of measuring progress and improvement of the teacher for

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[9] D. A. Robertson, "Personnel Methods," *The Educational Record. Supplement X* (July, 1928), 54.

[10] T. W. Hepner, "Better Judgments of Men," *Industrial Phychology I* (Jan., 1926), 19-24.

[11] H. Hartshorne, M. A. May, and J. B. Maller, *Studies in Service and Self-Control* (New York: The Macmillan Company, 1930).

[12] P. M. Symonds, *Diagnosing Personality and Conduct* (New York: The Century Co., 1932), 74.

the benefit of the administration. Little or no thought was given to anyone else except the ones in service. Those who were preparing to teach had little to encourage or guide them in their endeavors. Recently, however, attention has been directed toward this latter group. It is this group for which the writer wishes to formulate a method of rating.

Besides the purpose of measuring progress and improvement as just listed above many others can be given:

1. For promotions, salary increases, and elimination of the undesirable teacher.

2. To accumulate facts and information for the principal or superintendent which may aid him in administrative and supervisory work.

3. To find effective methods of training and preparing teachers for service as well as for teachers in service.

4. For the purpose of selecting teachers, determining which ones not to rehire or discovering those who should be transferred to other departments.

5. For the purpose of evaluating personnel in the schools.

THE USE OF RATING SCALES

The items to be listed under use of rating scales will be very similar to those under purpose of rating scales. In fact, it is difficult to make a fine distinction. Use, however, involves the actual putting to work of a method or system.

1. Rating scales have been used for investigation, promotions, salary increases, transfers, evaluating test results, employment, and reemployment.

2. By using rating scales individuals may be grouped into quartiles. It is very easy thus to see the two extremes, the exceptionally strong and the exceptionally weak ones. The two groups are of major concern to the administration of schools.

3. Promotion and advancement should be the consideration given the former; instruction, transfer, or adjustment for the latter.

4. Ratings are useful in that they initiate, stimulate, and keep alive the personnel spirit and furnish information and material with which to make research. This enables the superintendent to formulate his opinion about the teacher's worth or value without having to give snap judgments.

5. The use of some method of evaluating teachers has a stimulating and educational effect upon the one who is doing the rating as well as the one who is being rated. The former is benefited by observing first hand the shortcomings or strong points of the subjects and the recognition of the importance of his responsibility for

providing proper supervision. The latter is benefited, if criticism is presented in a tactful way, by gaining wholesome and unbiased views of himself. He is also stimulated to do his best because he knows that records are being made and he wants to appear as favorable as possible in the eyes of his superior or executive.

THE NEED FOR RATING SCALES

The principle source of trouble with the use of rating scales in the past has been our failure to realize that a good rating scale is as difficult to construct as a good test or an experimental measure of any kind. Some of the important things to incorporate into a rating scale are attitudes, personality, and character of the individual. These aid in helping the executive to discover the value of the individual to him or to the institution.

One of the greatest needs for rating scales is to make teachers more critical of their own work, whether this be in training or in service, in order that more efficient individuals may be available for the specified task in which they are engaged.

There is apparent need today for valid methods which will measure the efficiency of teachers more objectively. Rugg says, "A scientific analysis of personality and objective tests of the dynamic traits," is needed. For "the complex traits of character must be measured objectively, not judged." He continues the discussion—"for the advancement of the science of education and the better fitting of people for their life work and play we need to analyze character in great detail and to measure it objectively."[13]

The fundamental complex attributes, personality, character, temperament, and disposition, have not been analyzed into their component parts. No adequate tests or scales can be made until this is accomplished.

Rating methods serve another need in the field of practice teaching or teaching while in training. These methods acquaint the teachers with the material and information which they will need when they go out in service. Ratings serve as a basis for self-improvements, basis for promotion, for marking, for conferences, and for recommendations. It is also one sure way of testing the rating scheme under actual working conditions.

THE PROCEDURE FOLLOWED IN CONSTRUCTING A SCALE

The first step taken in endeavoring to set up a scale was the search of the field for sources of information and materials from which to build a bibliography and form a background for ensuing survey and research. The next immediate step was the collection,

[13] H. O. Rugg, "Is Rating of Character Possible?" *Journal of Educational Psychology*, XIII (January, 1922), p. 87.

sorting, and assembling of the material in the form of notes and scales. Many types of scales were discovered and collected from the materials and readings, and many others were sent for from publishers.

After twenty-five scales of various kinds had been collected the next step was the preparation of a chart. This chart contained four headings, namely: personality and appearance, instructional methods, management of classroom or gymnasium class control, and discipline and class organization, under which were listed many of the items found in the twenty-five scales scrutinized. After all the items of each of the twenty-five scales were listed and checked, frequencies were counted under each item and totals made. The highest number of frequencies found was eighteen; the lowest number of frequencies was one; the average number of frequencies was six.

The next step was the construction of a check list from the items on the above described chart which had, at least, a frequency of six. A few other items were added by the author. This check list was then sent out to twenty outstanding professional men and women in the field of physical education who had experience in directing practice teaching. These last two steps were taken in order to find out what the outstanding educators working along this line felt were the most important items to be included in a scale of this kind.

The items which were finally used in the scale were taken from the check lists sent back by these educators and others were added which seemed important from an empirical standpoint. Items checked worthless or little important on these check lists were not used; only those checked important or essential were used.

Needless to say these check lists proved a very valuable help in selecting the items to be used in constructing the scale. The type and style of the scale constructed is the result of intensive study and research for the kind of a rating device which could be well adapted to school use in the field of physical education. The same is true of the terminology employed. The rating device set-up below will coincide with many of the criteria of a good rating scale, and will measure the individual qualities of the teacher which it is supposed to measure. If the method and technique of the optimum rating scheme cannot be applied it ceases to be of paramount value. On the other hand, if method and technique of a rating device can be administered and applied it is more valuable even though it may not exactly measure up to the standards set up for a good rating scale.

Physical Education Teacher Rating Scale
West Virginia University
Randolph W. Webster, Associate Professor

Name of Student Teacher.....
Local Address.....Phone.....Class.....
Home Address.....

Teaching Course No.....Subject Taught.....
School where teaching is done.....Location.....
Grade.....Semester or term.....

Main Headings	Profile and Summary of Ratings: Profile 1—1.5—2—2.5—3—3.5—4—4.5—5	Av. Score
I. Personality & Appearance	.....	.....
II. Class Organization	.....	.....
III. Class Management	.....	.....
IV. Teaching Skill	.....	.....
Combined Numerical	1—1.5—2—2.5—3—3.5—4—4.5—5	Av.
Combined Letter	E———D———C———B———A	Av.

Comments

Name of Rater.....Title.....Date of Rating.....

Characteristic	Value of Score	Very Poor Low 5% 1 E	Poor 20% 2 D	Good Mid. 50% 3 C	Very Good 20% 4 B	Excellent High 5% 5 A	Score	Remarks
I. Personality and Appearance								
A. Intelligence								
1. General intelligence								
2. Common sense								
3. Initiative and self reliance								
4. Ability to adjust to situation								
5. Creative								
B. Self control and alertness								
1. Resourceful								
2. Dependable								
3. Poise								
4. Confidence								
C. Physical Qualifications								
1. Health								
2. Posture								
3. Impairments (structural)								
4. Dress, clean, neat, appropriate								
5. General appearance								

Characteristic	Value of Score	Very Poor Low 5% 1 E	Poor 20% 2 D	Good Mid. 50% 3 C	Very Good 20% 4 B	Excellent High 5% 5 A	Score	Remarks
D. Voice								
1. Quality								
2. Pitch								
3. Volume								
E. Manner								
1. Friendly								
2. Cooperative								
3. Meets people easily								
4. Enthusiastic								
5. Optimistic								
6. Thoughtful								
F. Fairmindedness								
1. Extends equal opportunities to all								
2. Corrects students without offending them								
3. Accepts criticism in good spirit								
Total of checks and scores I.								Av. I. score
II. Class Organization								
A. Class and Gymnasium Routine								
1. Starts and closes class promptly								
2. Distributes & collects towels, clothing, and equipment efficiently								
3. Pupils enter and leave without waste of time								
4. Makes accurate records of attendance, medical and physical examinations, achievement tests, classification and accidents and keeps them in accessible form								
5. Divides time adequately for dressing, roll taking, class period, showers, and redressing								
B. Control of Pupils								
1. Possesses skill in demonstrating motor activities								

Characteristic	Value of Score	Very Poor Low 5% 1 E	Poor 20% 2 D	Good Mid. 50% 3 C	Very Good 20% 4 B	Excellent High 5% 5 A	Score	Remarks
2. Meets situations easily and quickly								
3. Spirit of cooperation exists between pupils and teacher								
4. Secures quiet and attention when desired								
5. Keeps pupils interested and active throughout class period								
6. Maintains proper supervision by setting example or by suggestion								
C. Procedure of Class Organization								
1. Classifies pupils according to their needs								
2. Classifies pupils by grouping together those with like interest and ability								
3. Insures a continuity of program								
4. Formulates a sound system of grading based on both objective and subjective measures								
5. Discourages excessive excuses from required work								
D. Sickness and Accident Measures								
1. Takes all precautions to prevent accidents, injuries, and exposure to pupils								
2. Keeps apparatus clean and in repair								
3. Reports accidents, injuries, sickness promptly and administers first aid								
4. Encourages healthful habits and ways of living by precept and example								
Total of checks and scores II								Av. II. score

Characteristic	Value of Score	Very Poor Low 5% 1 E	Poor 20% 2 D	Good Mid. 50% 3 C	Very Good 20% 4 B	Excellent High 5% 5 A	Score	Remarks
III. Class Management								
A. Management of Gymnasium, Locker Rooms and Athletics Field								
1. Sees that the gymnasium, locker rooms and showers are kept clean, well ventilated, and lighted.								
2. Sees that the courts, athletic fields and diamonds are well marked according to specifications								
3. Sees that sufficient number of courts and diamonds are laid out and kept in condition								
B. Care and Organization of Materials and Equipment								
1. Keeps the equipment (mats, apparatus) and supplementary materials (ropes, gloves, charts) clean, and safe, in repair and in order								
2. Arranges equipment to be used by pupils before class time.....								
3. Stores equipment not in use								
Total of checks and scores III								Av. III. score
IV. Teaching Skill								
A. Planning and Organizing Lessons								
1. Constructs lessons which provide for differences of pupils' interests and abilities								
2. Arranges lessons in proper sequence of learning								
3. Knows subject matter..								
4. Plans for instructional, participation, relaxation, and corrective periods								

Characteristic	Value of Score	Very Poor Low 5% 1 E	Poor 20% 2 D	Good Mid. 50% 3 C	Very Good 20% 4 B	Excellent High 5% 5 A	Score	Remarks
5. Centers subject matter around pupils' needs and life situations.....								
6. Works out details before class period.....								
B. Directing Activities								
1. Provides opportunities for pupils to enjoy the program and gain in skill.....								
2. Shows pupils how to use leisure time.....								
3. Ascertains capacity and experience of children								
4. Analyzes and corrects pupils' mistakes								
5. Explains and demonstrates skills and techniques of games								
C. Appraising Pupil Achievement								
1. Checks pupils' progress by examinations, tests and measurements								
D. Assigning Activities								
1. Assigns activities which involve the entire group, according to their needs and abilities..								
E. Use of Language								
1. Possesses ability to explain								
2. Enunciates words correctly								
3. Has effective command of English								
4. Has vocabulary of choice words within grasp of pupils.....								
5. Avoids the use of slang and profanity								
Total of checks and scores IV								Av. IV. score

DIRECTIONS FOR USING SCALE

The author has endeavored to construct a scale which is concise, inclusive, and easy to score. It may be used by directors of practice teaching to rate student teachers or for student conferences; by student teachers themselves to analyze their own work for the purpose of ascertaining their own progress. In rating the teachers on the various qualities check only those subdivisions under the four main headings of Personality and Appearance, Class Organization, Class Management, and Teaching Skill which have an adequate basis for judgment. The adequate basis for judgment must be formulated only from observed performance.

SAMPLE RATING

Characteristic	Value of Score	Very Poor / Low 5% / 1 / E	Poor / 20% / 2 / D	Good / Mid. 50% / 3 / C	Very Good / 20% / 4 / B	Excellent / High 5% / 5 / A	Score	Remarks
F. Fairmindedness								
1. Extends equal opportunities to all						√	5	
2. Corrects students without offending them				√			3	
3. Accepts criticism in good spirit			√				2	
Total of checks and scores I							10	3.33 Av. I. score

The following steps are necessary in making a rating:

1. Place a check (√), opposite the item on which the teacher is being rated, in the quintile marked A, B, C, D, E, which represents the degree the individual possesses this quality. Rate the teacher only on those items on which there is available data.

2. Total the checks at the foot of each column opposite the "Total Checks and Scores."

3. In the column marked "Score" enter the value of each check for each item. The number at the top of the respective columns indicates the value of the check.

4. Total all the scores under the division of "Personality and Appearance" at the foot of the column in the line opposite "Total Checks and Scores." Divide the sum by the number of items rated under this heading. Write the quotient in the line after "Av. score I." Use the same procedure in finding the averages for the other three headings.

5. On the front page of this rating scale provision is made to summarize the average scores for all the four main headings and to construct a profile. Place in the column marked average score on this page the average score for each of the four main headings; compute the final combined average and enter it at the foot of the column.

6. In order to construct the profile, find in each line opposite the general heading a point which represents the value of the average score for that respective heading. Join these points by drawing a line from point to point. If ratings are desired in terms of percentages this may be found by dividing the combined average scored by 5, which is the highest possible combined average score. Ratings may be converted into a letter grade by using the letter corresponding to the numerical value indicated.

SUMMARY AND CONCLUSIONS

We have seen from the review and study of the literature, materials, and various productions in the field of measuring and rating individual qualities, that rating schemes of one kind or another are not new but have, comparatively speaking, a rather ancient origin. We have also seen that the characteristics to be measured vary greatly, namely, from the color representation scheme of Galton's to some of the present-day personality rating scales. The purpose, use, and need for rating scales have been discussed. Finally a system for measuring and evaluating physical education teachers has been explained.

The important thing which this piece of research has uncovered is the fact that there is no one best rating scheme which can be used universally. Due credit should be given to scientific measuring systems, but the system which is constructed should first be founded on practical administrative principles. If measurements are desired for certain situations, the scale should be constructed around the conditions concerning these situations. It is better to construct a rating device for a particular use than to try to adapt a scale which has been built for another purpose. It is very helpful indeed to have the statisticians and technicians set up standards for us if we can use them, but if all the standards are not adaptable to the actual situations, only those which are applicable should be considered. Much criticism of rating scales can be avoided if the builders of scales will consider the actual situation first, study it, and collect necessary data and then construct the scale. Work from the practical to the theoretical, not from the theoretical to the practical.

Action Current Study of the Rectus Abdominalis as a Postural Muscle In Arm Movements

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INTRODUCTION

IN THE main, the present-day statements and opinions of kinesiology in the field of physical education have been based largely upon anatomy, with special emphasis upon the points of muscular attachments, direct observation of muscular action in specific movements, analysis of cinematographic pictures, and upon the observation of movements caused by electrical stimulation of peripheral muscles.[1, 3, 4, 5, 9*] It is not the purpose of this paper to disparage the very real contributions of these techniques to the study of kinesiology and thus to a better understanding of physical education activities; however, that these approaches alone have not been particularly fruitful seems evident in the diverse systems of physical training, in the general disagreement as to what constitutes proper form and technique in physical education activities, and in the variety of corrective systems.

The principal limitation of the above approaches is that they offer no opportunity for securing objective measures of the details of contraction patterns and movement excursions; *viz.*, the incidence of muscular contraction in relation to the movement, the effect of muscular contraction upon the moving member at any point within the movement cycle, and the relationship of supporting musculatures. Electrical techniques, however, are now available for obtaining precise and objective kymographic records of muscular contractions and make possible simultaneous recording of muscular contraction and movement excursions. These techniques of movement analysis thus offer a definite experimental program for physical education. Through this movement analysis program a systematized body of facts may be built up from which to approach the problems involved in understanding and teaching physical education activities.

This paper describes a method for recording simultaneous

This experimental study was carried out as a constructive residence problem in physical education, State University of Iowa. The study was directed by R. H. Stetson and J. M. Snodgrass.

* Superior figures refer to bibliography at end of article.

movement excursions and muscle action potentials and summarizes an exploratory investigation into the function of the rectus abdominalis in raising the arms forward and overhead, the effect of increasing rate of arm movement, and the effect of increasing the mass or load.

METHOD AND APPARATUS

Simultaneous records of arm and shoulder movements and action currents from the lower left and right segments of the rectus abdominalis were taken on a Teledeltos Polygraph. The Polygraph has been described by Snodgrass.[10] Teledeltos paper type H, as supplied by Western Union, was used for recordings. Actual recording was accomplished by an electro-chemical reaction which was caused by the passage of a minute electric current from electrically conducting stylus tips through partially conducting teledeltos paper to a metal plate at the back. All stylus tips were made of .0003 stainless steel, spring-temper wire.

Arm and shoulder movements were recorded with a thread-and-rubber-band system.[6, 7, 8, 11, 12, 13] For the arm movement, the thread was attached to a ten-inch piece of one-half-inch doweling or a 5.5 lb. dumbbell which the subject grasped with both hands. The thread carried a small stainless steel marker and was attached to a rubber band at the opposite end. This maintained a light tension and allowed the marker to follow the arm movements. For the shoulder movement, the thread was attached to a leather collar which was fastened around the subject's neck. This thread also carried a stainless steel marker, and it too was attached to a rubber band at the opposite end. Both the arm and shoulder movements were reduced in recording by inserting rubber bands between the subject and the marker. The arm movement was reduced to approximately 1/45 of actual excursion, the shoulder movement to 1/12 of actual excursion.

Action currents were picked up with circular surface electrodes of copper, 3 cm. in diameter. The electrodes were held to the muscle with specially constructed suction cups.* Two cups were placed on each half of the lower segments of the rectus abdominalis. (By each half is meant the muscle fibers on either side of the linea alba; by lower segment is meant that portion of the muscle below the umbilicus, Fig. 2.)** The amplifiers have been described by Brown, Hudgins, and Sperry.[2, 8, 11]

Miniature electro-dynamic markers, possessing a frequency response from 0 to beyond 500 cycles per second, were used to record

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* The vacuum cups were designed and constructed by Mr. James M. Snodgrass, Research Instructor, Psychological Laboratory, Oberlin College.

** Figures and explanations will be found at end of article.

the action currents. The markers were developed in the Oberlin Psychological Laboratory and have been described by Brown.[2]

A copper screen cage 6′ x 6′ provided shielding for the subject against stray electrical fields during the recording process. The subject was also grounded with a large surface electrode on the left thigh. Time was recorded by means of a synchronous motor making one revolution per second.***

Sixty-four subjects were used in the experiment. Records were taken while the subject raised his arms forward, overhead, and down to thighs at gradually increasing speed. This movement was performed both while grasping a piece of doweling and a 5.5 lb. dumbbell. Figure 3 is representative of the records obtained. In all records the upward movement of the arm is indicated by the upward direction of the arm-movement line. The dip across the top of the arm-movement line is due to the fact that the subject did not stop the arm movement when directly overhead but allowed his arms to carry backward and, consequently, downward. The forward movement of the shoulder is indicated by the upward direction of the shoulder-movement line.

The movement of raising the arms overhead and down to the thighs is considered a complete movement cycle. The beginning of the action currents for a single contraction is taken as the point of incidence for that contraction. Measurement of the incidence of contraction is made from the beginning of the arm movement. That the action currents obtained are from the rectus abdominalis and not a composite of contractions from the rectus and obliques is clearly indicated in Figure 4.

RESULTS

Relation of Arm and Shoulder Movements

For every arm movement cycle there are two shoulder movement series: as the arms are raised forward to shoulder height, the shoulders move backward; as the arms move from shoulder height to overhead, the shoulders move forward; as the arms are lowered to shoulder height, the shoulders move backward; as the arms continue from shoulder height to thighs, the shoulders move forward (Fig. 1). Superimposed over the shoulder movement series of backward-forward-backward-forward there is a slow movement of the shoulders forward and backward of the original starting position. This latter movement is apparently an extremely arbitrary matter and, even in the individual subject, occurs over a varying number of arm cycles or shoulder movement series.

*** The Oscillograph Lebaratory, Department of Psychology, Oberlin College, will furnish, on request, details of electrical circuits and apparatus, suction cup electrodes, and vacuum system.

Relation of Movements and Muscular Contraction

In six subjects there is almost continuous contraction of both columns throughout the period of recording. In all other subjects there are generally single contraction pulses for each arm movement cycle (Fig. 3). There are, however, occasional intra-cyclic shifts and variations: in some instances there is a shift from single pulses for each cycle to a varying series of pulses, although there is no great increase in rate of movement (Fig. 5); in other instances there occur cycles in which pulses from one or both rectus columns drop out (Fig. 7). These shifts, when they occur, generally last for only a few cycles.

Although the individual subject tends toward uniformity, it is impossible to find any precise relationship between muscular contraction and movement. The single pulses commence sometime during the forward and upward movement of the arm and they are over before the arm begins its downward course, but they may occur during any portion of the movement. In relation to the shoulder movements, the pulses take place during some portion of the first backward and forward movements; they do not occur during the latter backward and forward movements of the series.

There is, of course, no causal relationship between the rectus contractions and arm movements. That, however, there should apparently be no relationship between the rectus contractions and shoulder movements is surprising. With their origin on the xiphoid process and the 6th, 7th, and 8th ribs and their insertion on the crest of the os pubis, the rectus columns might logically be considered as directly instrumental in maintaining the balance of the shoulder girdle over the pelvis (Fig. 2, I). The mechanical advantages of its line of pull should make the rectus a major muscle in keeping and in bringing the shoulder girdle forward to a balanced position. But this does not appear to be the case.

Nature of Rectus Action

Table I gives readings from continuous movement cycles of a representative subject. A comparison of the incidence of contraction of the left and right columns indicates that the rectus columns do not necessarily function in a completely synchronous manner. It is, in fact, more the exception than the rule to have the columns contract simultaneously.

As an exploratory investigation into the reason why contractions from either or both columns should occasionally drop out, action currents were taken from the upper and lower segments of the left rectus of several subjects. Figure 8 is representative of the records obtained. There is considerable independence of action between the upper and lower segments of the same column; the main

TABLE I

EFFECT OF INCREASING RATE AND MASS OF LIMBS

No Weight			*With Weight*		
Arm Mvt.	Left Rectus	Right Rectus	Arm Mvt.*	Left Rectus**	Right Rectus***
2.05 sec.	.32 sec.	.32 sec.	2.80 sec.	.22 sec.	.24 sec.
2.00	.30	.32	2.64	.28	.32
2.05	.36	.38	2.16	.24	.35
1.90	.35	.38	2.14	.18	.19
1.64	.26	.25	2.05	.22	.25
1.66	.28	.28	1.95	.24	.28
1.50	.20	.13	2.05	.25	.28
1.42	.26	.28	2.10	.26	.26
1.35	.20	.24	1.82	.24	.26
1.26	.28	.28	1.64	.18	.16
1.16	.15	.12	1.46	.12	.14
1.15	.16	.20	1.32	.15	.12
1.14	.20	.20	1.30	.10	.10
1.02	.15	.12	1.34	.16	.18
.94	.10	.09	1.20	.08	.10
.90	.12	.12	1.30	.15	.10
.80	.08	.10	1.34	.16	.11
.88	.10	.05	1.32	.08	.07
.88	.14	.08	1.16	.02	.04
.90	.11	.12	1.08	—.01	—.01
.86	.12	.11	1.12	.02	.02

* Arm Mvt.: Duration of arm movement.

** Left Rectus: Incidence of contraction in lower left segment of rectus abdominalis.

*** Right Rectus: Incidence of contraction in lower right segment of rectus abdominalis.

contraction for each movement cycle shifts from one segment to the other. It is suggested as a tentative explanation that in movement cycles in which contractions do not appear in the lower segments the contractions occur in the upper portion of the rectus. Why there should be this shift cannot, as yet, be stated.

EFFECT OF INCREASING RATE OF MOVEMENT

Table I shows that, for both with and without weight, as the rate increases the incidence of contraction shifts forward in the movement cycle. As the maximum rate is obtained, the rectus columns fixate into continuous contractions. Figure 6 illustrates this change from single contraction pulses for each movement cycle at a low rate to fixation as maximum rate is approached. This is in agreement with the finding of Stetson and Bouman.[12]

EFFECT OF INCREASING LOAD

A comparison of the incidence of contraction with and without weight in Table I shows that, at comparable rates of movement, the incidence of contraction with weight occurs earlier in the movement cycle. Similar results were found in a study by Hudgins.[8]

DISCUSSION OF RESULTS

The bony framework of the shoulder girdle acts as a base and provides the fulcrum from which the arm movements take place.

It is, however, not to be supposed that this base is rigid and fixed. As pointed out by Stetson and Throner: "The bony framework is a group of yielding, shifting levers. The bony framework meets the varying strains of the moving limbs by the changing contractions of the large muscles. The large muscles bind the supporting members together and shift their position with the varying strains of the moving limbs."[13] In performing the arm movements in this study, the musculature about the trunk, including the rectus abdominalis provides the postural support for the shoulder girdle. The sequence of backward-forward-backward-forward of the shoulders is the result of an action-reaction relationship (Fig. 1). The adjustment of the trunk muscles to the strains of the moving limb is indicated in the action of the rectus abdominalis.

At present, it is impossible to state precisely in what manner the rectus contributes in the maintenance of a postural base. It appears that the rectus does not function in keeping the shoulders balanced over the pelvis. There are rectus contractions during the first backward-forward movements of the shoulders, and it might be interpreted that the rectus acts in bringing the shoulders forward to a balanced position over the pelvis; there are seldom, however, rectus contractions during the latter backward-forward movements of the shoulder series. It is possible there may be pelvic changes to account for this difference. In personal observations, the writer finds that in raising the arms overhead the pelvis tips forward, and in lowering the arms the pelvis tends to tip backward. These pelvic shifts may also account for the contraction variations which occasionally appear in movement cycles. A further study in which both the shoulder and pelvic movements are recorded may give the explanation.

In a movement which involves only simple backward extension of the trunk and which is not complicated by any twisting or turning, it might be expected that the rectus columns function as a unit. But this is not the case. There are not only differences in the incidence and termination of contractions between the individual columns, but the preliminary evidence indicates there are also extensive differences between contractions in the upper and lower segments of a single column. The present experimental evidence does not permit any statement as to the cause for these shifts in contraction. They are, however, indicative of the changing, dynamic adjustment of postural support to the moving limbs.

The effect of rate and mass upon the incidence of contraction as found in this study is in complete accord with the conclusion of Hudgins: "Any factor which increases the work to be done advances the contraction of the muscles in the movement cycle. Increasing the amplitude, increasing the rate, increasing the load of move-

ment, all cause the contraction to occur earlier and earlier in the movement cycle."[8] When the mass is held constant and the rate is increased, the rectus contractions are advanced in the movement cycle. When the rate is held constant and the mass is increased, the contractions are again advanced in the movement cycle.

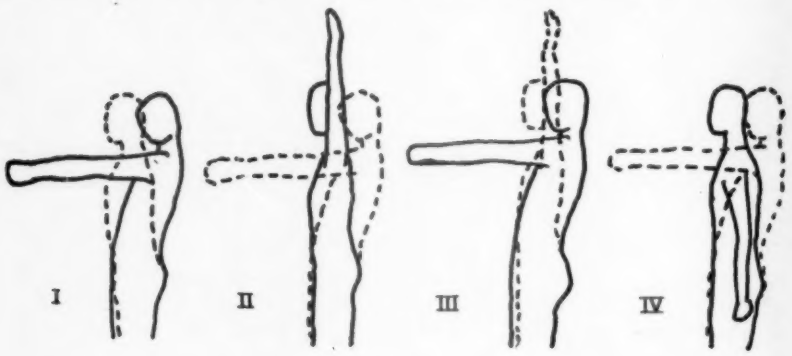


FIG. 1

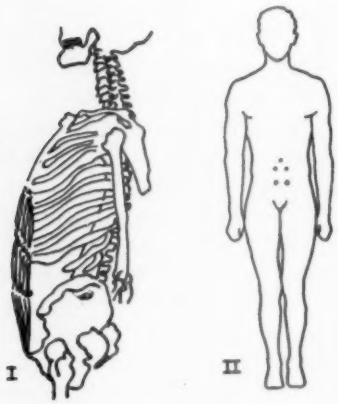
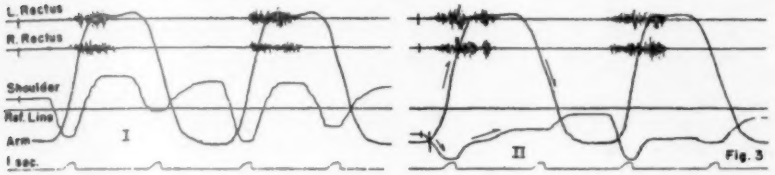
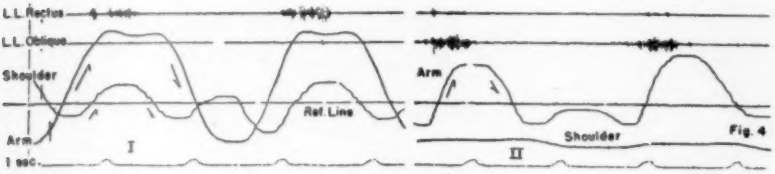


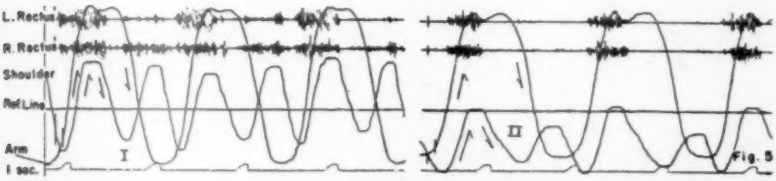
FIG. 2

FIGURE 1. ACTION-REACTION OF ARM AND SHOULDER MOVEMENTS. Broken outlines: position from which movement proceeds. Solid outlines: position to which movement is made. I. Action of arms forward and upward; reaction of shoulders backward. II. Action of arms upward and backward; reaction of shoulders forward. III. Action of arms forward and downward; reaction of shoulders backward. IV. Action of arms downward and backward; reaction of shoulders forward.

FIGURE 2. ATTACHMENTS OF RECTUS ABDOMINALIS AND POSITION OF ELECTRODES. I. Origin of rectus abdominalis on ziphoid process and the cartilages of the 6th, 7th, and 8th ribs. Insertion on the crest of the os pubis. II. Position of electrodes on rectus abdominalis.







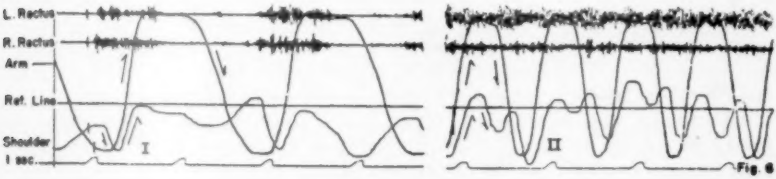


FIGURE 3. EFFECT OF INCREASING LOAD OF ARM MOVEMENT. L. Rectus: Ac. Cur. lower left segment of rectus. R. Rectus: Ac. Cur. lower right segment of rectus. Shoulder: Shoulder movement. Ref. Line: Reference Line. Arm: Arm Movement. 1 sec.: Time Line. I: Arm movement with no weight. II: Arm movement with 5.5 lb. dumbbell. Comparing with I shows that with increase in load the contractions come earlier in the movement cycle.

FIGURE 4. ISOLATION OF RECTUS ABDOMINALIS. L.L. Rectus: Ac. Cur. from lower left segment of rectus. L.L. Oblique: Ac. Cur. from Oblique muscles at lower left. The electrodes were placed 3 cm. to the left of those on the rectus. I: Raising the arms forward, over head, and down to thighs there is considerable muscular activity in the rectus and almost no activity in the obliques. II: Bending the trunk to the left there is considerable muscular activity in the obliques and negligible activity in the rectus.

FIGURE 5. SHIFTS IN RECTUS CONTRACTIONS. L. Rectus: Ac. Cur. lower left segment of rectus. R. Rectus: Ac. Cur. lower right segment of rectus. Arm: Arm movement—no weight. I: Although there are the usual contraction pulses in both rectus columns for each movement cycle, there is extensive muscular activity between cycles. II: Single contraction pulses for each movement cycle.

FIGURE 6. EFFECT OF INCREASING RATE OF ARM MOVEMENT AND SHIFTS IN CONTRACTION FORCE BETWEEN LEFT AND RIGHT COLUMNS OF RECTUS. L. Rectus: Ac. Cur. lower left segment of rectus. R. Rectus: Ac. Cur. lower

right segment of rectus. Arm: Arm movement—with weight. I: There are separate contractions for each movement cycle. II: As the arm movement approaches maximum rate, there is continuous muscular activity from cycle to cycle. The records also show a shifting of contraction force between left and right columns of rectus. In II the right rectus contraction force drops considerably below that of the left.

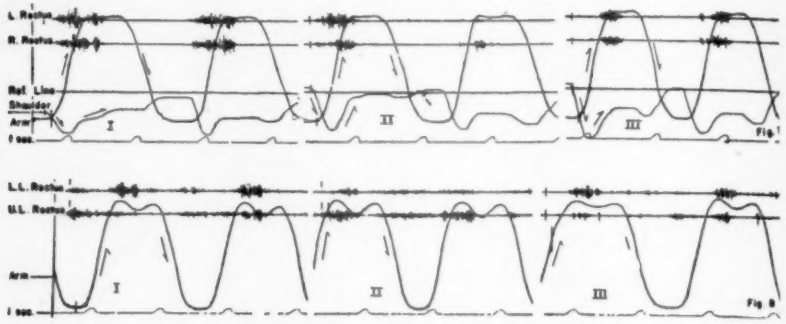


FIGURE 7. SHIFTS IN CONTRACTION OF LEFT AND RIGHT RECTUS COLUMNS. L. Rectus: Ac. Cur. lower left segment of rectus. R. Rectus: Ac. Cur. lower right segment of rectus. Arm: Arm movement—with weight. I: Shows strong contraction pulses for both left and right columns of the rectus. II: In the second cycle there is negligible muscular activity in lower left segment of rectus. In lower right segment there is greatly reduced activity. III: The contraction pulses of both columns are comparable in intensity; however, they are shorter in duration and come later in the movement cycle.

FIGURE 8. COMPARISON OF MUSCULAR CONTRACTIONS FROM LOWER AND UPPER SEGMENTS OF ONE RECTUS COLUMN. L.L. Rectus: Ac. Cur. lower segment of left rectus column. U.L. Rectus: Ac. Cur. upper segment of left rectus column. Arm: Arm movement—no weight. I, II, III: Consecutive cuts from one record. This figure shows that the lower and upper segments of one rectus column are capable of acting quite independently of each other. The main contraction pulse for each movement cycle shifts from one segment to the other. Although there are clear pulses in one segment or the other, or in both, for each movement cycle, these records show considerable muscular activity between cycles.

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Some Physiological Aspects of Physical Fitness

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IN the physiological aspects of physical fitness we have to do with all the functions of the living body. However, I do not expect to discuss the entire field of physiology but shall limit myself to the consideration of a few of these physiological characteristics.

To me physical fitness means the ability of the human to adjust himself to his environment. Man's equipment for fitness may be divided into three main categories; namely, the morphologic, physiologic, and psychologic. The physical form and structure of the body constitute the morphologic aspect of the equipment. In large part these are determined by heredity, but very few today doubt the statement "use makes the organ." Heredity determines the possible course and limits of development, but the use of an organ is absolutely necessary for its proper and full development. Graded and frequent uses of organs are the instruments of physiologic development; by these the capacity for activity is enlarged and a nicety of adjustment obtained. The mind is the master of the living machine; it, too, acquires greater capacity and a better equilibrium and adjustment with graded and proper use. In proportion as these three categories of the body are properly developed and maintained, there is preparedness for activity and a relative freedom from fatigue; that is, there is some degree of physical fitness.

Perhaps in this group we are interested in particular in four characteristics of physical fitness all of which may be modified by training: namely, strength, speed, skill, and endurance. However, since most of our physical fitness tests involve strength and endurance, my remarks will be confined to a consideration only of these.

The strength of muscle is directly proportional to the area of its cross section. Muscle fibers are unable to reproduce; hence an increase in strength of a muscle must be due to changes within the fibers already present. Abundant evidence indicates that the structure of a muscle can be greatly modified by use. The sarcolemma becomes thicker and tougher, and there is an increase in the amount of connective tissue within the muscle. The activity of a muscle causes an increase in the size of the individual fibres. In every muscle there are latent or unused fibers and fibers that are small from lack of use. These develop in response to the increased demand made upon them.

However, the gain in power of a muscle as a result of use is out of all proportion to its gain in size. This suggests that the quality of the contraction is improved. This improvement may be associated with an actual chemical change by which (a) fuel is made more available, (b) fuel is stored in greater amount, (c) oxygen is more abundant due to a more adequate circulation of blood through the muscle, (d) better coordination of the action of the individual muscle fibers and more complete use of all the fibers.

The color of an active muscle is darker than a sedentary one due to an increase in the hemoglobin content which indicates a more favorable condition for obtaining oxygen.

Continued use of a muscle results either in the formation of new blood capillaries or in the opening up of hitherto unused capillaries. These provide for a more advantageous circulation and, therefore, a better supply of fuel and oxygen and removal of waste substances.

Coordination is a great contributor to the strength of muscular contraction. Not only is this true with regard to the agonists and antagonists but also the timing of impulses which reach the individual muscles. The role of the forebrain and cerebellum are extremely important in coordination of movement. While we are prone to look upon the training of these parts of the body as of paramount importance in the development of skill, we should not lose sight of the fact that proper coordination is essential in the development of maximal strength.

Endurance is an extremely important feature of physical fitness. This involves the development of the respiratory and circulatory systems, and equally with them the development of neural capacity. As in the heat engine, nothing is accomplished in the living organism without combustion and the energy so liberated. Of the many factors concerned in maintaining the normal functioning of a living organism, respiration is probably the most important. Every manifestation of life involves the liberation and utilization of free energy, and in nearly all forms the requisite energy is obtained from oxidative processes in the cells concerned. An adequate supply of oxygen is therefore a fundamental requirement for maintaining the activity of any living cell belonging to the animal body. Furthermore, the carbon dioxide formed in intracellular oxidations must be removed if the oxidations are to continue unabated; otherwise an accumulation of this end product of the oxidative reactions will slow and eventually stop them. Respiration is the staff of life. Bread alone will not suffice. It must be burned.

Respiration involves the coordinated participation of tissue fluids, blood, the circulation, many muscles, and a considerable part of the central nervous system. Not only does the circulation play an

integral part in respiration but also provides the transportation system for food, waste, and hormones, and provides a means for the distribution and elimination of heat.

Among the respiratory changes occurring as a result of frequent and regular exercise may be mentioned the lung capacity and economy of ventilation. The expansion of the chest is increased; the rate of breathing is slowed and its depth is augmented. In the sedentary individual large portions of the lungs may be physiologically closed off from the air inhaled while with training the entire lung volume easily becomes accessible, so that the blood may be exposed to oxygen over as much as 100 square meters of surface, instead of a fraction thereof. Lung capacity cannot always be judged by external measurements, since they take no account of the diaphragm. Of course the participation of the various parts of the chest wall will depend to some extent upon the type of activity, i.e., swimming, distance running, etc.

Exercise will result in enlargement of the chest during the period of growth but will not have much influence on the size thereafter.

For the same accomplishment the trained man breathes less air and absorbs a greater proportion of the oxygen from the air he breathes than does the untrained man. The trained man ventilates his lungs both during rest and in exercise more economically than does the untrained. This is particularly advantageous during exercise, in that exertion then causes an increased utilization of oxygen and an increased production of carbon dioxide without an exorbitant increase in the minute volume of breathing. An increase in the capillary diffusion area of the lungs is a large factor in this gain in economy; by it a greater amount of blood can be aerated in the lungs in a given time.

Active tissues, in the last analysis, depend upon the circulation of the blood for their supply of oxygen and nutriments, and for the removal of lactic acid, carbon dioxide, and other wastes. It is not surprising, therefore, to find the current belief that the circulation of the blood is often the limiting factor in a man's ability to respond to requirements of physical exertion. Such being the case, we should be able to show that the ability to increase the minute volume of blood flow is much improved, and that the heart becomes more efficient during a period of training.

It has been found that in strong athletes the pulse rates are 10, 20, or even 30 beats slower than in men of sedentary habits. Training of single subjects results in slowing of the resting pulse rate. Acute infections cause an increase in the pulse rate but this influence is much less pronounced in the trained than in the untrained man. It has been concluded that the regular exercise of

training brings about a marked increase in the tone of the vagus center in the brain and that this makes itself evident in the slow pulse of the athlete.

While the trained man's heart has the advantage of starting at a slower rate of beating, on the whole it accelerates as many beats in response to the task as does the heart of the untrained subject.

It has been maintained for some time that the efficiency of the heart begins to progressively fall off at rates between 160 and 180 beats per minute. With the high rates the diastole of the heart becomes too brief to allow the ventricles to relax and refill completely.

The fundamental difference between the trained and untrained man for a particular task is that the heart of the trained man pumps more blood per minute with fewer strokes than does that of the untrained man. Carefully graduated exercise improves the nutritive condition and develops the muscular power of the heart at the same time that it develops the skeletal muscles. The weight of the heart is directly related to the general development of the bodily musculature and is an expression of the work performed just as is the development of the body musculature.

One of the elements in the functioning of a strong heart is a highly efficient coronary circulation. It is believed that in the heart, as in the skeletal muscles, there is either a formation of new capillaries or the opening up of hitherto unused capillaries.

As a result of such changes the heart of the trained man empties itself more completely at each beat than the weaker heart of the untrained man.

The findings of blood pressure measurements in the resting, trained individuals show no difference from that of untrained. However, training does diminish the height to which the systemic blood pressure rises during work.

The number of red blood corpuscles in the blood is very definitely changed by exercise and training. The red corpuscle serves primarily as a carrier of oxygen, but of almost equal importance is its ability to carry carbon dioxide and to serve as a buffer against acids and alkalies. Ordinarily, when unusual demands are made within the tissues for a supply of oxygen, the organism responds by increasing the number of red corpuscles and the percentage of hemoglobin in each unit volume of blood. Such an increase occurs when a man goes to a high altitude. During exercise the number of red blood cells may be increased as much as 13 per cent within a period of three minutes.

The mechanism by which this increase in number of red blood cells is accomplished has many possible explanations. Today the debate has narrowed down to two theories, one maintaining that

there is a reserve or dormant supply of red cells stored away somewhere in the body to be called out when occasion demands, and the other maintaining that fluid passes out from the blood into the actively contracting muscles, a change that would reduce the total blood volume and would not increase or decrease the total number of circulating corpuscles. Perhaps a true explanation lies in a combination of these two effects.

A period of training greatly facilitates the functioning of the bone marrow so that it more adequately meets the increased demands. Thus an individual of sedentary habits who indulges in prolonged strenuous muscular effort may show some degree of anemia for a period of from several days to two or three weeks. On the other hand, regular exercise, or a period of physical training, so develops the red marrow of the bones that any ordinary destruction of corpuscles is quickly made good during, or soon after, exercise and that the total mass of red blood cells is permanently increased. Thus, the oxygen-holding power of blood is increased.

It has been demonstrated that the trained man can perform a given amount of work with a smaller consumption of oxygen and with a greater mechanical efficiency than the untrained man. However, training may increase the resting B.M.R., decrease it, or produce no change. Cells may become more efficient in the use of oxygen in which case there may be a fall in B.M.R. If a period of physical training should at the same time result in an increase of the mass of active tissue in the body, then we must assume that the added protoplasm requires its share of oxygen and that this increases the total oxygen requirement of the body. It is easy to see how these two working together could account for all the findings. However, we must not lose sight of the fact that the trained man is able to relax to a greater extent than the untrained one.

Perhaps the real value of exercise lies mainly in its effects upon the metabolism of the tissues themselves. Quoting Bock (1928), "Although little of a definite nature is known about the mechanism of cell oxidation, we believe that the capacity for exercise is bound up with changes in the oxidative processes within the cell. A search for the secret of efficiency displayed by certain athletes does not yield an answer in terms of increased efficiency of breathing or circulation alone. It appears to lie rather in the muscle cells themselves."

When the work demanded of muscles is within the ranges of speed and force of which they are capable, the limit of exertion is fixed by the capacities of the mechanisms which supply the muscles with metabolic necessities and which remove their waste products.

On rare occasions the muscles may fail for lack of energy-yielding compounds. The muscles are more immediately dependent on oxygen than on any other substance. Lactic acid accumulates within them when they do not receive this gas in adequate amounts. The accumulation of lactic acid in the blood and the muscles up to the fatigue maximum will certainly stop the machine. It is evident that factors which limit the intake and delivery of oxygen to the tissues are ordinarily the cause of the failure of the machine.

The ventilation of the lungs is rarely, if ever, inadequate as is indicated by the fact that the partial pressure of oxygen in the alveoli of the lungs is maintained at least at 100 mm. and is frequently above that amount during physical activity. This is the pressure that nearly saturates the blood with oxygen. Evidently a man can breathe far more air than the amount corresponding to even the largest increase in the rate of circulation of the blood.

The circulation, however, is usually looked upon as the important factor in the limitation of muscular exertion. The chief determining factor, therefore, in the oxygen intake is the rate of circulation of the blood. Some look upon the oxygen-holding capacity of the blood as the last reserve the body has to draw upon. When the body encroaches on the lower third of this reserve the athlete comes to the end of his physical power. Others say that the coronary blood supply to the heart may be the weak link in the chain of circulatory adjustments of muscular activity. Still others believe that voluntary effort is limited by failure of the functional capacity of the cardio-respiratory system as a whole and not by premature failure of any one member of this team. It is not of great importance whether we regard one member more than another as the cause of failure. The outstanding point is that there is failure in the delivery of oxygen to the muscles because the capacity of one or more of the adaptive mechanisms is finally overtaxed.

In the final analysis, physical fitness then appears to be limited by the cardio-respiratory system.

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Schneider, Edward C., *Physiology of Muscular Activity,* (Philadelphia: W. B. Saunders Co., 1939).

A Selected Bibliography on Physical Fitness

Prepared by

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*A Selected Biography**

THIS bibliography of books on Physical Fitness is selective. It includes books, published through October, 1942, dealing with wartime phases of physical fitness, supplemented by a few of the better older books to complete the scope of the work. The dynamic aspects of physical fitness are now emphasized by the Physical Fitness Division of the U. S. Office of Education and Federal Security Agency. A larger number of books are given for *Sports and Conditioning Exercises* to emphasize the positive developmental aspects of fitness. Other phases are not neglected and some of the better books are listed for:

1. General Hygiene.
2. Nutrition.
3. Standards and Measurements of Fitness.
4. Scientific Analysis.

Hygiene and nutrition courses will need those in the first two categories. Administrators and teachers are dependent upon measurement and standards to motivate the pupils, to establish status as a basis of guidance, and to evaluate improvement. Most of all they need to know the practical activities. Students in professional

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*** Prepared by a committee representing the American Physical Education Association and the American Library Association composed of Thomas K. Cureton, Ph.D., University of Illinois (Chairman). (Physical Education and Recreation.) Clair E. Turner, D.P.H., Massachusetts Institute of Technology. (Health Education and Nutrition.) Emma McCloy Layman, Ph.D. (Mental Hygiene.)**

This project was suggested originally by Carl M. White, of the American Library Association, Director of the University of Illinois Library. It came as a follow-up to Bulletin 23, of the American Council on Education dealing with Higher Education and National Defense which specified that a more definite and consistent program for physical fitness should be developed and required of all students at this time. In taking this matter up with the Department of Physical Education at the University of Illinois the matter was referred to the Research Council and the Governing Board of the American Association of Health, Physical Education, and Recreation, which confirmed the above-named committee to do the job of selecting the titles. Acknowledgment is made for assistance rendered in compilation by Warren Huffman and Norma Mulvane, in the office of the chairman, University of Illinois.

classes will need books which deal with the basic scientific principles. All aspects are important for the professional worker.

The activity books were selected on the basis that they represent activities for physical fitness which are being emphasized in the present wartime emergency. The following areas of emphasis were recognized and are represented in the selections:

1. Swimming and Warfare Aquatics.
2. Calisthenics and Gymnastic Conditioning Exercises.
3. Fundamentals of Team Combative Sports.
4. Wrestling, Boxing, and Rough and Tumble Fighting (Judo).
5. Body Mechanics and Weight Control (Posture, Flexibility, Body Type).
6. Corrective Exercises and Adapted Sports.
7. Recreational Games and Social Activities for Relaxation.

The selections also represent materials for various age and sex groups:

1. Boys and Girls.
2. Young Men and Cadets.
3. Young Women.
4. Middle-Aged Men and Women.

The work is not comprehensive but highly selective for each of the areas mentioned.

GENERAL HYGIENIC ASPECTS OF FITNESS

AARON, HAROLD. *Good Health and Bad Medicine.* 1942. (4th printing) 328p. McBride, $3.

A family medical guide, sponsored by the Consumer's Union of the U.S., Inc., which popularizes health information for the consumer. The book aims to tell the ordinary consumer what to do and what not to do about his own private ills. The book is ever-conscious of the patent medicine abuse.

BAIRD, CHARLES M. *Health and Longevity.* 1941. 157p. Christopher, Boston, $1.75.

A popular summary of important facts related to health and longevity. Deals with various phases of mental and physical hygiene, but is largely devoted to diet as the key to health. One section is devoted to the psychology of human nature.

BAUER, W. W. *Health Questions Answered.* 1942. 368p. Bobbs-Merrill, 69c.

This book is a compilation of questions selected from among more than ten thousand letters asking almost fifteen thousand questions.... The answers have bees procured from authentic sources, including many consultants of national repute, through *Hygeia.*

BRAGG, PAUL C. *Outwitting Illness.* 1940. 273p. Aetna Print. Co., Los Angeles, Calif., $1.

A popular treatise on physical fitness procedures. Covers many practical problems of personal hygiene.

BROWNING, ETHEL. *Health and Fitness.* 1937. 254p. Rich & Cowan, Lond., 3s 6d.

A popular book covering hygienic procedures, applied to the relatively fit and also to the slightly unfit. Material is applied to the school

child, the young adult, to middle-aged and old people.

CANNON, WALTER B. *Digestion and Health.* 1936. 160p. Norton, $2.

The story of digestion and health considering the nature of hunger, thirst, and the inter-relationships with bodily vigor and excitement popularly presented.

DEVAN, ARTHUR S. *Exercise Without Exercise.* 1941. 86p. Dodd, $1.25.

The author attacks all the popular exercise dogma of the day. In a simple, amusing way, he unfolds his theory that standing, sitting, walking, and breathing are all that is necessary to develop muscle and that setting up exercises are useless and harmful. It is a far cry from the real work done by physical educators, but one which might appeal to the sedative business man and the urban lady.

DIEHL, HAROLD S. *Healthful Living.* 1935. 345p. McGraw-Hill, $2.50.

Presents a simple guide on the subject of health for all those who are interested in getting the most out of the body with which they began life, interested in avoiding the snares for the unwary who think too much about their health, and interested in the development for the future of a race of men and women capable of carrying on the American tradition of healthfulness.

EMERSON, WILLIAM R. P. *The Diagnosis of Health.* 1932. 272p. Appleton, $3.

A book which outlines a college physical fitness clinic book based largely upon nutritional appraisal and a personal hygiene program. Develops a self-rating health intelligence test and quotient. Includes procedures for a nutrition class.

FISHER, IRVING, and HAVEN EMERSON. *How to Live.* 20th ed. 1938. 422p. Funk & Wagnalls, $2.50.

A practical handbook of hygiene in simple and non-technical language.

———and EUGENE L. FISK. *How to Live.* (19th ed.) 1932. 371p. Life Extension Institute, New York, $2.

Rules for healthful living prepared in collaboration with the Hygiene Reference Board of the Life Extension Institute. Presents preventive procedures to be used in the war against lowered physical efficiency and chronic preventable disease. Represents a collaboration of some sixty authorities on health. Covers air, food, poisons, activity, weight regulation, helpful exercises, shoes, alcohol, tobacco, and mental hygiene.

GARRUD, W. H. *The Complete Jujitsuan.* 1929. 125p. Methuen, Lond., 5s.

An older book written by a man who was well versed in jujitsu, contains many excellent illustrations as well as numerous hints on this art.

GERLING, C. J. *The Complete Weight Reducer.* 1941. 246p. Harvest house, New York, $3.

A comprehensive book on all of the various methods of weight reduction. Deals with foods and fads, drugs, special devices and concludes that except for a few glandular cases the solution is diet and exercise. The material is alphabetically arranged.

HAGGARD, HOWARD W. *Man and His Body.* 1938. 594p. Harper, $4.

A broad and mature approach to personal hygiene written by an eminent physiologist for employers, college students or beginning medical students.

———and E. M. JELLINEK. *Alcohol Explored.* 1942. 297p. tables. diag. Doubleday, $2.75.

A sincere, unmoralizing approach to the subject of alcohol. Two well-qualified authors discuss the consumption of alcohol and its extent, actions in the body, effect on behavior, resultant diseases both mental and bodily, and inebriety.

HEISER, VICTOR G. *You're the Doctor.* 1939. 300p. Norton, $3.

brings him home with a generous margin of energy for study, active pleasures, happiness, and health in general."

———*You Can Stay Young.* 1939. 143p. Stokes, $1.50.

Reviews the theories of youth and summarizes acceptable scientific principles in popular form. Gives dietary program, endorses regulated exercise, and emphasizes sleep and proper use of medical science.

KEITH, ARTHUR. *The Engines of the Human Body.* 1925. 343p. Lippincott, $5.

A popular book based on a series of lectures given to an audience of boys, girls, men, and women. Gives a detailed explanation of the body as if it were composed of various machines found in the industrial world.

KIMBALL, FRANK T., AND ABBOTT W. ALLEN. *How to Feel Better and Look It.* 1942. 280p. Duel, Sloan & Pearce, $2.50.

This book has been written to give you, in easy "how to" terms, the scientific facts you really need to know about yourself, along with certain practical wisdom learned the hard way by men and women who have applied the facts to their own and their pupils' bodies—made visible in candid camera photographs.

MCGOVERN, ARTIE. *The Secret of Keeping Fit.* 1941. 242p. Garden City, $1.

This book is full of specific exercises that will tone the body to peak condition, and teems with physical and psychological tips on the care and feeding of adults. It forever blasts away for one the quackery of health charlatans.

MOORE, H. H. *Keeping in Condition.* 1936. 136p. Macmillan, 1.40.

Covers the essentials involved in training—exercise, fresh air, diet, rest, and the control of the innner conscience. Gives a good summary of the dangers to virility.

An analysis of the common elements of life pertaining to physical fitness with special reference to diet and exercise. Written for the public in popular style.

———*Toughen Up America!* 1941. 228p. McGraw-Hill, $2.

An inspirational treatise on the needs and methods for getting fit. Deals in a popular manner with foods, germs, sleep, exercises, and a variety of health habits. Contains a description of ten body-building exercises.

HILL, CHARLES. *Your Health in Wartime.* 1941. 48p. Univ. of London press, 1s.

Deals with the spread of germs, immunization and inoculation, cleanliness, warm feet and cool heads, sleep and rest, and food.

HISS, JOHN MARTIN. *New Feet for Old.* 1937. 161p. Doubleday, $2.

Three people out of five in these United States suffer from some form of foot trouble. Thirty per cent of these wince under the stress of those twin abominations—broken arch and bunion. It is in an effort to relieve some of this needless, nonsensical suffering that this little book is written.

JEFFERY, CLEMENT. *Fit After Forty.* 1939. 211p. Muller, Ltd., Lond., 5s.

Deals with middle-age problems of fitness, stressing the place of moderate exercise and diet. Has sections on constipation, winter health, change of life, and the mind after forty.

JOSSELYN, DANIEL W. *Live Up to Yourself.* 1941. 190p. Longmans, $2.

This is a popular book written to show people how they can make the most of their energy. "I propose this book as an equal training system for the business athlete: a training system which sends him to the office full of enthusiasm, which keeps him vital and pleasant in the face of trying work, and which

PARRAN, THOMAS. *Shadow on the Land.* 1937. 309p. American Social Hygiene Association, $1. A frank and widely read presentation of the venereal disease problem.

RICE, THURMAN B. *Living.* 1940. 464p. Scott, Foresman, $2.25.

Covers in popular style modern principles of personal, mental, and environmental hygiene.

ROBERTS, HARRY. *Keep Fit in War Time.* 1940. 90p. Watts, Lond., 1 crown.

It is addressed to those classed as civilians . . . an important contribution to our country's success consists in everyone doing his best to be fit in body and in mind. Some of the more outstanding changes in our environment caused by wartime conditions are discussed and some suggestions offered as to how we may best adapt ourselves to the altered conditions.

SOKOLOFF, BORIS. *Middle Age is What You Make It.* 1938. 204p. Greystone press, $1.75.

A book which summarizes the evidence on middle-age health. Develops a positive theory of living the dynamic life. Includes case histories of dozens of important men who have demonstrated unusual vitality and longevity.

SRIGLEY, ROBERT S. *When to See Your Doctor.* 1941. 44p. College Book Company, Columbus, O., 35c. Written by a doctor of medicine. It includes the most important causes of death, for which doctors can do something, if the patient sees the doctor in time. It gives the symptoms of the diseases and what should be done.

STEIN, JOSEPH M. *Your Heart.* 1941. 240p. Alliance Book Corp., $3.50. A helpful book on the heart for the layman. In this book may be found the way to heart health. It includes simple, sensible rules for healthful living. The scope of the work covers both remedial and and preventive phases.

STEINHAUS, ARTHUR H, and F. M. GRUNDERMAN. *Tobacco and Health; Some Facts About Smoking.* 2d ed. 1941. 48p. Association Press, 35c.

A summary of facts about smoking culled from various scientific experiments in physiological and commercial research laboratories. Shows the harmful effects of smoking on the physiological mechanisms.

TURNER, CLAIR E., and ELIZABETH MCHOSE. *Effective Living.* 1941. 432p. Mosby, $1.90.

Healthful and effective living as an individual, as a member of the family, and as a member of the community. Contains questions and standards for self-checking.

WILLIAMS, JESSE FEIRING. *Personal Hygiene Applied.* 7th ed. 1941. 627p. Saunders, $2.50.

A well written and widely used general text in personal hygiene.

NUTRITIONAL ASPECTS OF FITNESS

BOGERT, JEAN. *Nutrition and Physical Fitness.* 3d ed. 1939. 566p. Saunders, $3.

A guide to health building through nutrition.

BORSOOD, L. J. *Vitamins. What They Are and How They Benefit You.* 1940. 193p. Viking, $2.50.

What each of the vitamins does in the prevention of disease and the maintenance of health.

CHANEY, M. S., and M. AHLBORN. *Nutrition. Rev. ed.* 1939. 436p. Houghton, $3.

The general nutrition problem.

COOPER, L. F., E. M. BARBER, and H. S. MITCHELL. *Nutrition in Health and Disease.* 7th ed. 1939. 712p. Lippincott, $3.

A consideration of the effects of inadequate diet upon health and a guide to proper eating.

EDDY, W. H. *What Are the Vitamins?* 1941. 247p. Reinhold Pub. Corp., $2.50.

The nature of the vitamins and the important facts science has accumulated concerning them.

PATTEE, ALIDA FRANCES. *Vitamins and Minerals for Everyone.* Hazel E. Munsell, technical advisor. 1942. 242p. illus. tables. Putnam, $2.

A convenient, well-arranged reference book written partly in question and answer form.

ROSE, MARY SWARTZ. *Feeding the Family,* 4th ed. 1940. 421p. Macmillan, $3.75.

A consideration of individual and family needs and practical ways of meeting them.

———*Foundations of Nutrition.* 3d ed. 1938. 625p. Macmillan, $3.50.

A widely used and not too technical presentation of the basic facts of nutrition.

SANSUM, W. D. *The Normal Diet.* 1930. 134p. Mosby, $1.

A statement of the fundamental principles of diet for the mutual use of physicians and patients. It is dedicated to an effort to prevent illness, relieve suffering, and prolong life through the proper use of food.

SHERMAN, HENRY C., and CAROLINE S. LANFORD. *Essentials of Nutrition.* 1940. 418p. Macmillan, $3.50.

A widely used college text.

TAYLOR, DEMETRIA. *The Nutrition Handbook.* 1942. 231p. Doubleday, $2.

A complete guide to the nutritional content of the food we eat.

MENTAL HYGIENE ASPECTS OF FITNESS

BURNHAM, WILLIAM H. *The Normal Mind: An Introduction to Mental Hygiene and the Hygiene of School Instruction.* 1924. 702p. Appleton, $3.50.

This book has to do especially with the mental health of normal children. It maintains the thesis that the essential characteristic of the normal mind is an integration of the personality that makes adjustment possible, and it discusses conditions and methods that tend to preserve and develop integration, as well as conditions and practices that tend to produce disintegration.

CLARKE, E. K. *Mental Hygiene for Community Nursing.* 1942. 262p. Univ. of Minn. Press, $3.50.

Prepared as an incentive and source of information to public health, school, and industrial nurses. Valuable for all health educators.

GRIFFIN, J.D.M., S. R. LAYCOCK, and W. LINE. *Mental Hygiene; a Manual for Teachers;* foreword by C. M. Hincks. 1940. 291p. diag. American Book Co., $1.75.

A comprehensive and practical book, written to foster a better union between mental hygiene and education. The authors display an adequate understanding of teachers' problems, and give many workable suggestions for handling these problems. There is a good chapter on physical handicaps as related to mental hygiene problems.

GRIFFITH, COLEMAN R. *Psychology and Athletics: A General Survey for Athletes and Coaches.* 1928. 281p. diag. Scribner's, $2.

Approach to subject is through the channels of experiment and observation rather than academic theory. What the book does chiefly is to take the phrases of coaches and newspaper reporters—"breaks of the game," "jinx," "on their toes," overconfidence," and examine their meaning in relation to mental processes and physical training.

JACOBSON, EDMUND. *You Can Sleep Well.* 1941. 288p. Tower Book, 49c.

This book tells you in an understandable and interesting way how to relax.

———*Progressive Relaxation.* 1929. 429p. Univ. of Chic. Press, $5.

A physiological and clinical investigation of muscular states and their significance in psychology and medical practice.

JASTROW, JOSEPH. *Keeping Mentally Fit.* 1930. (5th printing) 315p. Garden City, $1.

A popular treatise covering problems of keeping happy, the cult of beauty, psychology of sport, and analysis of typical cases. A guide to everyday psychology.

MCKINNEY, FRED. *Psychology of Personal Adjustment; Students' Introduction to Mental Hygiene.* 1941. 636p. illus. diag. tables. Wiley, $2.75.

A book which frankly attacks the problems of the student that are most vital to his personal adjustment and which offers him factual material on these problems. May be used with freshman and sophomore classes, but suitable also for older college students.

NASH, JAY B. *Building Morale.* 1942. 154p. A. S. Barnes, $1.

A non-technical discussion of morale and methods which may be used in democratic countries to build it. Techniques for building morale are described in terms of physical, mental, and spiritual fitness.

PINTER, RUDOLPH, JON EISENSON, and MILDRED STANTON. *The Psychology of the Physically Handicapped.* 1941. 391p. diag. tables. Crofts, $3.

A review of experimental material dealing with the achievement, development, habits, and problems of the physically handicapped child. Contains much material of value to the physical education teacher and health educator.

RIVLIN, HARRY N. *Educating for Adjustment; the Classroom Applications of Mental Hygiene.* 1936. 419p. Appleton-Century, $2.25.

This book takes the mental hygiene point of view into the classroom and indicates how the principles of mental hygiene can be applied effectively through the teacher's attitude, school activities, and procedures without involving her in the responsibilities and duties of the trained psychiatrist.

SHAFFER, LAURENCE FREDERIC. *The Psychology of Adjustment; an Objective Approach to Mental Hygiene.* 1936. 599p. diag. Houghton, $4.50.

A text dealing with both theoretical and practical aspects of mental hygiene. Although intended primarily as a college text, the book contains much of value to teachers.

SHERMAN, MANDEL. *Mental Hygiene and Education.* 1936. 295p. Longmans, $2.25.

This book has been planned to aid teachers to discover and understand the emotional and personality problems of their pupils and to institute classroom treatment.

SYMONDS, PERCIVAL M. *Mental Hygiene of the School Child.* 1936. 321p. Macmillan, $1.75.

A simple, readable text, designed to interpret the meaning of mental hygiene for teachers, and stressing the positive, preventive aspects of mental hygiene.

THORPE, LOUIS P. *Personality and Life; a Practical Guide to Personality Improvement.* 1941. 266p. illus. Longmans, $2.50.

A non-technical book on mental hygiene written chiefly for the benefit of younger college students who are eager to understand their own natures as well as how to avoid the pitfalls of psychological disorders.

SPORTS AND CONDITIONING EXERCISES

ARMBRUSTER, DAVID A. *Competitive Swimming and Diving.* 1942. 301p. Mosby, $3.25.

Contains a descriptive analysis of the start, the sprint crawl, the middle-distance crawl, the distance crawl, the back crawl, the breast stroke, and diving. It is valuable also for two chapters on conditioning and training.

BARTON, FRED B. *It's Fun to Keep Fit: a Guide to Games and Sports.* 1940. 160p. Harper, $2.

This book presents a wide variety of recreational activities, both organized and unorganized. It is designed for people of all ages, all seasons, all hours, all moods, and all pocketbooks.

BAUMGARTNER, ALBERT J. *Posture Training and Remedial Gymnastics.* 1941. (Mimeoprinted) 145p. Burgess Pub. Co., Minneapolis, $2.25.

This book has been written for teachers of physical education. It is concerned chiefly with the essentials of body posture, considered from the standpoint of the anatomical and static-dynamical superstructure of the body . . . and supplemented by illustrations suitable as bases for the exercises.

BUKH, NIELS. *Fundamental Gymnastics* (tr. from the 2d Danish ed. by Emily R. Andrews and Karen Vesterdal). 1938 (4th printing). Dutton, $2.

The book stresses the development of balance, flexibility, agility, strength, and fundamental coordinations by means of exercises largely without apparatus. Gymnastics are presented as fundamental to sport. Bukh's type of program has won honors the world round and is authoritatively recognized as sound for basic physical conditioning.

CRAMPTON, C. WARD. *Boy's Book of Strength.* 1936. 257p. McGraw-Hill, $2.25.

This book is an effort to give the boys of preparatory school age a program of health management based upon their own experience with life as they are really living it. It seeks to strengthen and support the work of the athletic coach, the gymnasium instructor, the teacher, parent, and physician.

——*Start Today! Your Guide to Physical Fitness.* 1941. 224p. Association Press, $1.75.

The book is meant for the individual, the doctor, the physical educator, and the soldier. Physical fitness is defined, and the importance of the medical examination is shown. Exercises are given as well as a discussion of diet and its relation to physical fitness.

——*Training for Championship Athletics.* 1939. 303p. McGraw-Hill, $2.50.

Written for every man who wants to excel in his chosen sport. It gives specific, scientific advice on the coordination of muscles and the development of good form for track, baseball, basketball, and football. Detailed rules for training are given.

CURETON, THOMAS K. *How to Teach Swimming and Diving.* 1934. 238p. Association Press, $3.

A book for teachers and supervisors which develops the philosophy, pedagogical principles, health control and management procedures, historical background, and modern methods of teaching beginners. Swimming is being unusually emphasized in wartime physical fitness to reduce the large percentage of non-swimmers, estimated as high as 50 per cent of the adult male population.

——*Warfare Aquatics.* 1943. 176p. 205 illus. Stipes Pub. Co., Champaign, Ill., $2.50.

An instruction manual and course syllabus for swimming in wartime. A comprehensive guide to warfare aquatics.

DUNCAN, RAY O. *Six-man Football.* 1940. 76p. illus. Barnes, $1.

Written especially for the person in the small high school who has been called upon to coach this new sport. Fundamentals are stressed just as they should be taught.

FAIRBAIRN, WILLIAM E. *Get Tough!* 1942. 120p. Appleton-Century, $1.35.

How to win in hand-to-hand fighting as taught to the British Commandos and the U. S. armed forces.

GALLAGHER, EDWARD CLARK. *Wrestling.* 1939. 91p. Barnes, $1.

An illustrated book on wrestling. Contains the best information the author has been able to assemble in the different groups of holds, trips, locks, and counters. Contains a chapter on training.

HARWOOD, ELIZA J. and R. B. WAGNER. *How To Train Your Body.* 2d ed. 1934. 150p. Baker, Boston, $1.50.

A book which combines some of the fundamental Swedish gymnastic work with harmonic (poise and expression) training.

HUNT, TERRY. *Exercise and Keep Fit.* 1940. 202p. Prentice-Hall, $1.96.

A practical book covering personal hygiene in the first half and a well illustrated exercise section in the remaining part. The final part lists celebrities who have been conditioned by the exercises.

KENNEY, H. E. *Rough and Tumble Fighting* (Personal Defense Tactics). 1942. 48p. Stipes Pub. Co., Champaign, Ill., $1.

This book gives many good tips on personal defense. Contains 83 illustrations. Suitable for civilians as well as those who will be engaging in hand to hand fighting in the armed forces.

KING, VICTOR H. *Be Physically Fit* (U. S. Army—West Point Cadets). 1941. 70p. West Point, 50c.

An authoritative and comprehensive, yet compact booklet on physical training for the individual, containing useful advice on matters of exercise, diet, and health, together with thirty excellent exercises for performance at home.

KIPHUTH, R.J.H. *How To Be Fit.* 1942. 131p. Yale University Press. $2.00.

Contains fifteen sets of conditioning exercises for individuals as Part I and five lessons of more strenuous exercises for partners or groups. Completely illustrated.

———*Swimming.* 1942. 110p. Barnes, $1.00.

Sound advice on training and practice for competitive swimming. Special conditioning exercises are included.

KNUDSEN, K. A. *A Textbook of Gymnastics.* 1924. 338p. Lippincott, $3.

A book which is highly selective of scientifically arranged Danish and Swedish exercises for developing fundamental aspects of motor fitness. Contains considerable teaching material as well as exercises for the principal anatomical parts of the body but also arranged to cover balance, flexibility, agility, strength, power, and endurance exercises as well as a few games.

KUWASHIMA, T. SHOZO, and ASHBEL WELCH. *Judo.* 1941. 119p. Prentice-Hall, $2.50.

This book gives thirty lessons in the modern science of jujitsu. "For this book we have selected only those movements which can be mastered by the average man, woman, or child,—movements which can be accomplished with but a small expenditure of strength, and without previous training or experience."

LANE, JANET. *Your Carriage Madam, a Guide to Good Posture.* 1934. 130p. Wiley, $1.75.

The girl's posture problem presented with humor and illustrated with drawings.

LEFFLER-EGNELL, BARBRO. *Slim and Supple.* 1934. 209p. Appleton-Century, $2.

Swedish exercises for women young and old. Ten lessons are recommended to women of all ages as a simple, pleasant way of keeping the physical proportions within limits and the body in full vigor. Each section is a complete lesson with practical exercises and illustrations to facilitate the reader.

MASON, B. S., and E. D. MITCHELL *Active Games and Contests.* 1935. 600p. Barnes, $3.

An encyclopedia of active games and contests classified as contests between individuals, contests between groups, goal and tag games, team games and miscellaneous activities involving personal combat, horseback riding, water, or winter. A reference book carefully indexed.

MCCLOW, L. L., and D. N. ANDERSON. *Play Gymnastics.* 1940. 153p. Crofts, $3.

Contains 850 informal play exercises for forty arrangements of gymnasium apparatus. It is designed for professional use in the school, college, playground, Y.M.C.A., Y.W.C.A., or church gymnasium, and it may be used as a manual for volunteer club leaders.

——*Social Games for Recreation,* 1935. 421p. $2.50.

Compendium of material for the party, the club, the playground, the camp, the picnic, and the home—social recreation. Includes dance and party events, combative councilring events, outing events, and a great variety of play activities.

MENSENDIECK, BESS M. *It's Up To You.* 1931. 200p. J. J. Little and Ives Co., New York, $3.

This book is written for women. The main purpose of the book is to define correct posture and show how it can be acquired. Contains numerous illustrations showing correct and incorrect posture in everyday movements.

NYE, DOROTHY. *Lady Be Fit!* 1942. 91p. Harper, $2.

A popular book which gives a clear statement of the personal problem of physical fitness which faces many citizens. It includes exercises and advice for energy, efficiency, and lasting health.

——*New Bodies For Old.* 1936. 135p. Funk & Wagnalls, $2.

This book points out why, where, and how to exercise for beauty and health. It is arranged for both the teacher and the average woman who is interested primarily in weight normalizing. It gives many illustrations, practical exercises, and sound advice on diet, post-pregnancy exercise, and posture.

PHELPS, WINTHROP M., and ROBERT J. H. KIPHUTH. *The Diagnosis and Treatment of Postural Defects.* 1932. 180p. Thomas, Springfield, Illinois, $4.

A book which emphasizes the relation between posture and preventive medicine. Covers practical phases of the body mechanics, diagnostic examination, and corrective exercises.

RAYCROFT, JOSEPH E. *Mass Physical Training.* 1924. 282p. United States Infantry Association, Washington, D. C., $3.

Outlines the program of athletics and physical training prepared by the Athletic Division of the War Department Commission on Training Camp Activities. Contains disciplinary drill, group games, combatives, efficiency tests, mass athletics, warfare aquatics, bayonet training drills as well as organization and administration material for the military camp setting.

REED, DUDLEY B. *Keep Fit and Like It.* 1939. 325p. McGraw-Hill, $2.50.

Explains briefly the physical and nervous makeup of the human body and its need for exercise. Shows how exercise can be fun instead of a chore. Different forms of exercise are evaluated and shown how they can be suited to individual requirements.

REILLY, HAROLD J. *The Secret of Better Health.* 1941. 221p. Carlyle House, $2.50.

Describes approximately 100 exercises in popular manner. Outlines program of conditioning for defense, largely applicable to women and middle-aged men. Gives exercises for reducing fat, dietetic instructions, posture exercises, and a variety of hygienic suggestions.

SCANNELL, JOHN A. *A Manual of Heavy Apparatus and Tumbling Stunts.* 1940. 46p. Burgess Pub. Co., Minneapolis, $1.50.

In the activities selected for you in this handbook you have those which have proved their values in use on the secondary and college level. No attempt is made to cover the wide field of stunts which may be used on lower levels. Neither are there listed stunts of the type which will challenge the competitive gymnast. Reference to satisfactory sources for this material, will, however, be found in the bibliography.

STAFFORD, GEORGE T. *Sports for the Handicapped.* 1939. 302p. Prentice-Hall, $2.75.

Outlines for physical educators, nurses, physicians, parents, and the handicapped a program of sports. Shows the need for adapted sports and the effect of physical handicaps on the personality. Classifies sports according to various physical handicaps.

———and RAY O. DUNCAN, *Physical Conditioning.* 1942. A. S. Barnes, $1.

This book touches on the needs of the average man and woman but is prepared mainly for use by coaches and athletes. The authors list and illustrate a series of exercises for conditioning in various sports including baseball, basketball, boxing, gymnastics, swimming, track, weight lifting, and wrestling.

———DECOOK, HARRY B. and JOSEPH L. PICARD. *Individual Exercises.* 1937. 111p. A. S. Barnes, $1.

The doctor, the physiotherapeutist, the physical educator, and the teacher will find this book helpful in selecting exercises for the large number of individuals who, because of physical defects, deformities, etc., should not be permitted (or are not able) to take the regular physical education work.

STALEY, S. C. *Calisthenics.* 1926. 338p. A. S. Barnes, New York, $3.

The book is the outstanding one on calisthenics and reflects the author's experience as supervisor of such work in World War I and as teacher of it at the University of Illinois. Contains nomenclature, teaching methods, lesson plans, and model lessons.

———*Conditioning Gymnastics.* 1927. 50p. $1.

Contains 134 exercises that are especially fitting in our present emphasis upon conditioning work. Exercises were originally used in the army. Excellent for early season conditioning work of athletes.

———*Games, Contests, and Relays.* 1924. 354p. A. S. Barnes, $3.

Author's aim was to collect into one volume all of the more important games, contests, and relays. Ignores the theory and describes activities classified for the lower grades, upper grades, junior high school, senior high school, college, and older adults.

STALEY, S. C., and G. T. STAFFORD. *Sports Curriculum.* 1940. 127p. Stipes Pub Co., Champaign, Ill., 60c.

Contains brief specifications for all of the service courses in physical education at the University of Illinois, and a selected bibliography for each.

STONE, HENRY A. *Wrestling, Intercollegiate and Olympic.* 1939. 323p. illus. Prentice-Hall, $3.

Gives the exact method of applying every standard hold, with more than 200 action photographs. Besides describing the science of holds, it teaches specific blocks and counters adapted to individual physiques, and gives advice on training, conditioning, and treatment and prevention of injuries.

TUNIS, JOHN R. *Sport for the Fun of It.* 1940. 340p. A. S. Barnes, $2.50.

A popular handbook of information on twenty sports that everyone can

play for their own enjoyment. Each sport is presented under Origin and Background, Equipment, Playing Area, Official Rules, and Bibliography.

UNITED STATES NAVAL ACADEMY, *Physical Training Manual.* 1942. 312p. United States Naval Institute, Annapolis, Md., $2.

Supersedes previous Naval Academy manuals of 1906, 1920, and the revisions of 1922, 1927, 1933, and 1936. It outlines the physical training requirements of the Naval Academy. As arranged it presents the fundamentals of practically all sports practiced by the Academy.

UNITED STATES NAVY TRAINING DIVISION. *Physical Fitness Program for High Schools and Colleges.* 1942. 57p. Bureau of Aeronautics, Navy Department, Washington, D. C., (free).

Outlines a program in physical fitness for educational institutions modeled somewhat after the Navy pre-flight school courses. Rugged health, endurance, strength, and agility are the goals. Outlines are included for defensive activities, military track and obstacle course, gymnastics and tumbling, swimming and lifesaving, and a few combative games.

UNITED STATES WAR DEPARTMENT. Basic Field Manual, *Physical Training.* FM 21-20. 1941. 211p. Govt. Print. Off., Washington, D. C., 30c.

Official specifications for the conduct of physical training in the United States Army. The book includes commands, formations, marching, disciplinary exercises, setting up exercises, combative exercises, various forms of mass athletics and group games, swimming and lifesaving, and rifle exercises.

———*Sports and Games.* (TM 21-220). 1942. 197p. Govt. Print. Off., Washington, D. C., 50c.

Basic rules and fundamentals of various sports are given. Covers archery, badminton, baseball, basketball, bowling, boxing, handball, horseshoes, soccer, softball, speedball, tennis, table tennis, touch football, track and field, volleyball, and wrestling.

VINCE, JOSEPH. *Fundamentals of Fencing.* 1940. 62p. illus. A. S. Barnes, $1.

Written in a concise manner. Covers the fundamentals for the three weapons: the foil, the epee, and the saber.

STANDARDS AND MEASUREMENTS OF MOTOR FITNESS

BOVARD, JOHN F. and F. W. COZENS. *Tests and Measurements in Physical Education.* 2d ed. rev. 1938. 427p. Saunders, $3.

A comprehensive book on tests and measurements in physical education. The text is arranged in three major parts: the status of measurement, the tools of measurement, and the theory and practice of test administration. Various physical fitness tests are described in the book.

BRACE, D. K. *Measuring Motor Ability.* 1927. 138p. A. S. Barnes, $2.

A motor ability test of 20 items arranged for scoring on the pass or fail basis and standardized largely on elementary and high school boys and girls. Includes the analytical work involved in developing the test.

COZENS, FREDERICK W. *Achievement Scales in Physical Education Activities for College Men.* 1936. 118p. Lea & Febiger, $2.50.

A comprehensive collection of performance scales in dynamic activities of fitness standardized on college freshmen and sophomore men. Covers 35 events with administrative suggestions for giving the events and using the scales.

———TRIER, M. H. and N. P. NEILSON. *Physical Education Achievement Scales for Boys in Secondary Schools.* 1936. 155p. A. S. Barnes, $1.60.

Scales for the measurement of motor fitness based on over 56,000 records from the junior and senior high schools of Los Angeles.

CURETON, THOMAS K. *A Guide to Tests and Measurements in Health and Physical Education.* 1936. 78p. School of Physical Education, Champaign, Ill. (mimeographed, printed cover, bound) $1.

A guide to the literature of tests and measurements in health and physical education. Contains indexes, abstracts, bibliographies, publishers, periodicals, best books, agencies, classification headings for searching, and selected references under 53 subheads.

———*Physical Fitness Workbook.* 1942. 180p. Stipes Pub Co., Champaign, Ill., $1.75.

A practical workbook for work in basic physical fitness emphasizing aspects of physique, organic efficiency, and fundamental motor capacity. Outlines a testing and exercise program for balance, flexibility, agility, strength, power, and endurance. Gives results of University of Illinois program with men.

A Study of Industrial Recreational Activities In Lafayette, Indiana

By Leroy E. Boothe
Purdue University

PROBLEM INVESTIGATED

THIS study* was made in order to determine: (1) the type of recreational activities in which men in industry would like to participate, (2) the reasons for non-participation, and (3) previous leadership experience in these activities.

SOURCE OF DATA

Two hundred and fifty questionnaires were filled in by men in industries in Lafayette, Indiana, during the period from June, 1941, to June, 1942. These men ranged in age from 20 to 70 years. This group of individuals was employed in electrical, automotive, textiles, wood, wool, metal, and rubber industries.

The questionnaire requested the following data:

1. Age and marital status.
2. Job operation performed.
3. Name of factory where employed.
4. The activity or activities in which participation was desired.
5. The activity or activities in which the person questioned has been a leader.
6. The reason why they have not participated in their favorite activity.

After compiling the data, the desire for participation in all activities seemed to be indicated. The following table indicates the per cent of the individuals studied who desired to participate in each activity listed.

TABLE I

Per Cent Desiring Participation In Each Activity In All Industries

Activity	*Per Cent*	*Activity*	*Per Cent*
Bowling	40.4	Billiards	19.6
Fishing	36.8	Horseshoe	17.2
Hunting	36.4	Cards	16.4
Basketball	33.6	Boxing	13.6
Rifle-pistol	33.2	Skeet shooting	12.8
Baseball	31.6	Social dancing	12.4
Golf	30.4	Bait casting	10.4
Softball	24.4	Roller skating	10.4
Automobile riding	24.4	Tennis	10.0
Swimming	23.6	Camera club	9.6

* Master's thesis, Purdue University, 1942.

Activity	*Per Cent*	*Activity*	*Per Cent*
Gardening	9.2	Science club	1.2
Crafts	8.8	Aviation	1.2
Skating	8.8	Football	.8
Singing	8.0	Badminton	.8
Ping pong	7.6	Soccer	.4
Riding	7.2	Dramatics	.4
Camping	6.8	Debate club	.4
Nature study trips	6.8	Croquet	.4
Hiking	5.8	Roquet	.4
Skiing	4.8	Hockey	.4
Field meets	4.4	Training dogs	.4
Volley ball	4.0	Motor boating	.4
Music (orchestral)	2.8		
Art	2.0	AVERAGE	11.6

This survey indicates the numbers of leaders, but has, in no way, evaluated the quality of leadership. Leadership experience was indicated, when considering all individuals, to be at a minimum. However, if the percentage was figured of only the individuals desiring to participate in the activity, enough leadership was indicated for the promotion and supervision of most of the activities.

TABLE II

PER CENT HAVING BEEN RESPONSIBLE FOR LEADERSHIP IN ALL ACTIVITIES IN ALL INDUSTRIES

*Activity**	*Per Cent*	*Per Cent of Leaders of Group Interested***
Basketball	9.6	28.5
Baseball	7.5	23.7
Softball	6.0	24.6
Golf	2.0	6.5
Bowling	1.6	3.9
Horseshoe	1.6	9.4
Swimming	1.2	5.1
Boxing	1.2	8.9
Camera club	1.2	12.5
Nature study trips	1.2	17.7
Ping pong	.8	10.5
Billiards	.8	4.1
Roller skating	.8	7.7
Music (orchestral)	.8	28.6
Singing (vocal)	.8	10.0
Volleyball	.4	10.0
Rifle-pistol	.4	1.2
Crafts	.4	4.5
Gardening	.4	4.3
Debate club	.4	100.0
Science club	.4	33.3
Fishing	.4	1.0
Camping	.4	5.9
Cards	.4	2.4
Croquet	.4	100.0
Roquet	.4	100.0
AVERAGE	.88	

* There were 46 activities.

** The per cent of leaders of the group interested was figured by finding the per cent of individuals indicating leadership experience of the number desiring to participate in each activity.

The following table lists the reasons for not participating in the various activities and the per cent of individuals choosing each reason:

TABLE III

PER CENT APPLYING TO EACH REASON FOR NON-PARTICIPATION IN ALL ACTIVITIES IN ALL INDUSTRIES

Reason	*Per Cent*
Insufficient time	38.7
Too expensive	17.6
Lack of place to participate	9.6
Conflicts with hours of work	6.6
Lack of leadership	5.6
Duties in the home demand attention	4.3
Lack of equipment	3.8
Physical disability	3.3
Lack of confidence in ability to participate	2.9
Attitude of friends toward activity	2.3
Other individuals seem uninterested and will not participate with me	2.1
Location of facilities is too distant	1.7
Poor health	1.0
Inadequate transportation	.7

The activities were divided into four groups: physical, cultural, outdoor, and social. The type of recreational activity desired did not change, with any degree of consistency, with the type of work the men were doing, as can be noted in Table IV.

TABLE IV

AVERAGE PER CENT DESIRING PARTICIPATION IN EACH PHYSICAL, CULTURAL, OUTDOOR, AND SOCIAL ACTIVITY IN EACH TYPE OF WORK

Activities	*Light*	*Medium*	*Heavy*	*All types*
Physical	15.9	17.4	16.5	16.4
Cultural	5.4	3.8	4.2	4.3
Outdoor	12.5	10.8	10.1	11.2
Social	15.0	13.7	15.6	14.4

SUMMARY

1. Bowling was the favorite sport of the individuals studied, with fishing, hunting, basketball, rifle-pistol, and baseball ranking in the order mentioned.

2. The present study indicated that physical activities were more desired than either outdoor, cultural, or social activities.

3. Cultural activities were chosen by a much smaller group than any of the other groups of activities.

4. Leadership experience was indicated in 26 of the 46 activities.

5. Leadership experience of the group studied was indicated to the extent of 6 per cent or more in only three activities, namely, basketball (9.6 per cent), baseball (7.5 per cent), and softball (6 per cent).

6. More leadership experience was indicated in physical activities than in outdoor, cultural, or social activities.

7. Outdoor activities had the least amount of indicated leadership experience.

8. The per cent of individuals indicating leadership experience, of the group desiring participation in the various activities, indicated sufficient leaders for most of the activities.

9. The leading reasons for non-participation were: "insufficient time," 38.7 per cent; "too expensive," 17.6 per cent; "lack of place to participate," 9.6 per cent; "conflicts with hours of work," 6.6 per cent; and "lack of leadership," 5.6 per cent.

10. In each group of activities "insufficient time" ranked first among the reasons.

11. "Too expensive" ranked second among the reasons in both physical and outdoor activities; third, in cultural activities; and fourth, in social activities.

12. "Lack of place to participate" ranked second among the reasons in cultural activities, while "lack of confidence in ability to participate" ranked second in social activities.

13. Individuals between the ages of 20 and 29 were located in medium and heavy types of work.

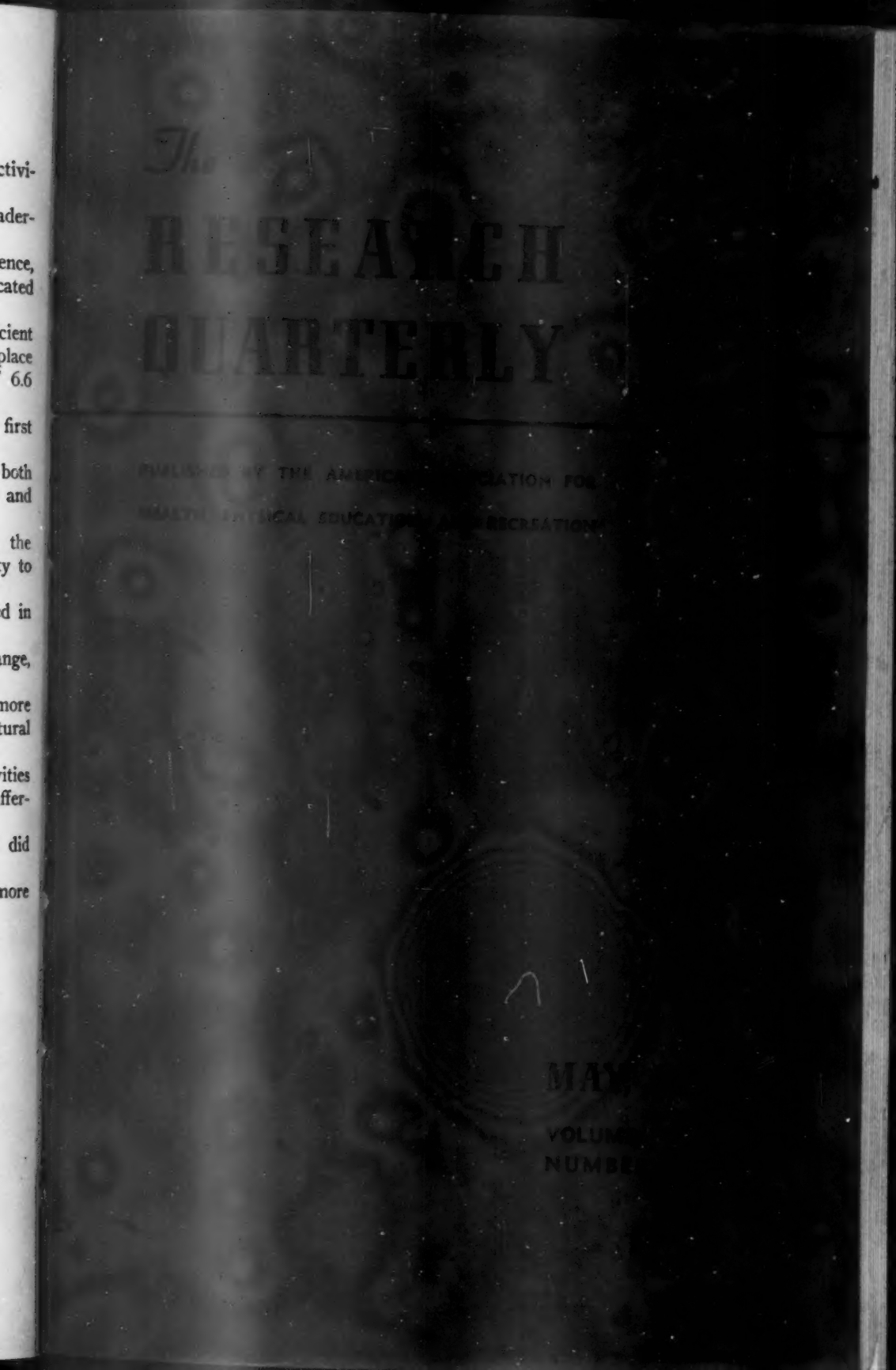
14. The type of recreational activity desired did not change, with any degree of consistency, with the type of work done.

15. Physical activities were desired for participation by more individuals in all types of work than social, outdoor, or cultural activities.

16. Married and single individuals placed the same activities in the first ten they chose for participation, but ranked them differently.

17. Single men ranked team or dual activities higher than did married men.

18. The married group seemed to enjoy outdoor activities more than did single men.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